NATURE

No. 4387 SATURDAY, NOVEMBER 28, 1953 Vol. 172

CONTENTS

	Page
Science in Australia	969
Birds of Scotland. By Seton Gordon, C.B.E.	971
Chemistry of Starch. By Prof. E. L. Hirst, F.R.S.	972
Cultural Anthropology. By Dr. Paul Bohannan	972
Engineering Mechanics. By Dr. R. E. D. Bishop	973
Elementary Animal Ecology. By T. H. Hawkins	973
Provisioning Expeditions in the Field	974
Mechanism of Phosphorylation in the Respiratory Chain. By Dr. E. C. Slater	975
Australian Commonwealth Scientific and Industrial Research Organization: Annual Report for 1951–52	978
Piltdown Man	981
Obituary: Dr. O. F. Hudson. By Dr. S. W. Smith, C.B.E.	982
News and Views	983
International Co-operation in African Botany. By J. P. M. Brenan	987
Genetics and Plant Pathology. By Prof. K. Mather, F.R.S.	989
Recruitment for the Civil Service: Report of the Commissioners for 1949–52	990
International Scientific Abstracting	991
Automatic Grain Counter for Assessing Quantitatively High-Resolution Autoradiographs. By Dr. R. A. Dudley and Dr. S. R. Pelc	992
The B-Vitamins in Wheat: the Unique Aleurone Layer. By Dr. J. C. Hinton, F. G. Peers and Dr. B. Shaw	993
Letters to the Editors:	
Fine Structure of the Extra-terrestrial Radio Source Cygnus I.—R. C. Jennison and M. K. Das Gupta	996
An Extended Radio-frequency Source of Extra-galactic Origin—R. Hanbury Brown and C. Hazard	997
Thermal Decomposition of Dolomite.—Dr. Robert Meldau and Robert H. S. Robertson	998
Creep Curve for a Precipitation-hardened Alloy.—G. C. E. Olds	999
Structure of Ion-exchanged Forms of Chabazite.—I. R. Beattie	999
Small-Angle X-Ray Scattering and Interparticle Interference in Rayons.—Prof. A. N. J. Heyn	1000
Use of Non-geometrical Perspective in the Two-dimensional Representation of Solid Objects.—Philip Short	1002
Pozzolanic Activity of Ash produced by the Eruption of Mt. Lamington, New Guinea.—K. M. Alexander and H. E. Vivian	1002
Amino-Acids and the Growth of Isolated Oat Embryos.—G. P. Harris	1003
Crystalline Inclusions in Aerobic Spore-forming Bacteria.—Dr. C. L. Hannay	1004
Acetylcholine in Blowflies.—Dr. S. E. Lewis	1004
Detection of Fœtal and Sickle-cell Hæmoglobins in Human Anæmias.—Dr. G. H. Beaven and Dr. J. C. White	1006
Prevention and Cure of Enzootic Muscular Dystrophy in Beef Cattle.—Dr. K. L. Blaxter and G. A. M. Sharman	1006
Linkage between Pulmonary Tumours and Vestigial Tail in the House Mouse.—Dr. W. E. Heston	1007
Transphosphorylation between Nucleoside Polyphosphates.—P. Berg and W. K. Joklik	1008
Culture of *Fucus* Hybrids.—E. M. Burrows and S. M. Lodge	1009
A Pedigree for Three Types of Colour-Vision Defect.—Dr. R. W. Pickford	1010
Zoological Nomenclature.—Francis Hemming, C.M.G., C.B.E.	1010
Recent Scientific and Technical Books	Supp. vi

Editorial and Publishing Offices of "NATURE"
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.
Telephone Number: Whitehall 8831. Telegrams: Phusis Lesquare London

Annual subscription £6, payable in advance, postage paid to any part of the world

Advertisements only should be addressed to
T.G. Scott & Son, Ltd., Crown House, 143–147 Regent Street, London, W.1
Telephone Number: Regent 3891

All rights reserved. Registered as a newspaper at the General Post Office

SCIENCE IN AUSTRALIA

THE visit of H.M. the Queen and the Duke of Edinburgh to Australia is a good occasion for British scientists to consider the short history of science in that country; for it is an exciting history and instructive in many ways. It is only 174 years since Joseph Banks proposed to a committee of the House of Commons that a colony might be established in Australia, to offset some of the embarrassments which the War of American Independence was causing in England; and it is only 165 years since Captain Phillip entered Port Jackson and settled with 717 convicts, 18 officers and 191 marines on the low rocky shores of Sydney Cove. Under such unpromising conditions the Commonwealth of Australia was born. While Captain Phillip and his staff were tentatively exploring the rocky forests and scrub which surround Port Jackson, James Hutton in Scotland published his "Theory of the Earth", Henry Cavendish was reading papers to the Royal Society, and William Smith was setting to work on his geological map of Britain. It would have needed a bold prophet to predict at that time that in five generations Australia would occupy a high and honourable place in world scholarship.

How has this impressive transformation occurred? The critical move was made about a century ago, when the citizens of Sydney and Melbourne each made a decision which turned their colonies from mere military and trading centres into the mainstream of civilization. In both cities universities were founded: the University of Sydney in 1850 and the University of Melbourne in 1853; and this happened at a time when there were only four universities in England and none in Wales. There was no meanness about the foundations. At a time when the University of Sydney had less than a hundred students, a hall and quadrangle were built there which would not look out of place in the Broad at Oxford, and the university buildings at Melbourne, if less impressive, are no less dignified. Adelaide and Tasmania followed suit. At the turn of the century Australia had four universities; it now has eight—including one postgraduate university—for a population considerably smaller than that of Scotland; and one student in about 270 of the population compared with one student in about 550 of the population in Britain. Until comparatively recently these universities were the only centres for science and scholarship in Australia. Once the initial enthusiasm had waned they were not well financed, and they had therefore to economize in the only way universities can—by having too few teachers; and this in turn hampered research. But they gave a sound training to undergraduates and sent many young men to complete their scientific apprenticeship in Britain. Besides the universities there were the State Departments of Agriculture; but these were of necessity concerned with short-term projects. Their staffs worked under constant pressure to solve day-to-day problems, and naturally they became more expert in applying science to practice than in extending the frontiers of science itself.

In 1900 the colonies of Australia coalesced to form the Commonwealth. The pattern of this inevitable but long-delayed development has had a profound effect on science in Australia; for the States retained many powers which (to an outside observer) would have been better handed over to the central government. For example, agriculture and forests remained the concern of the States; so did minerals and artesian water; so did education: and by and large State policy was narrower, more parochial, less far-sighted than Federal policy, and certainly not so well financed. Some of the consequences of this were serious to science. There was at the outbreak of war in 1939 no Federal geological survey, no Federal control of forestry, and no Federal aid to education; and in none of these fields did the States consider it was worth while to spend much money on research.

Australia's scientific life was saved by the Council for Scientific and Industrial Research, set up in 1926 under the Federal Government. It began as a modest organization to do long-range research into problems of primary production. By the time the War had ended and the C.S.I.R. was twenty years old, it had become one of the largest and most distinguished scientific organizations in the world. Its annual budget ran into six figures. Its divisions covered not only agriculture but also radiophysics, food technology, fisheries and industrial chemistry. Its policy was to give its staff the maximum freedom to do long-range research even though it might offer no immediate prospect of benefit to Australian agriculture or industry. The wisdom of this policy has been abundantly demonstrated. Improved yields in crops and wool and meat alone must have paid many times over for the whole cost of running the Council since 1926. A survey of its work during 1951–52 appears on p. 978.

The architect of this scientific organization is Sir David Rivett, who left the chair of chemistry in Melbourne to become its chief executive officer. It must have given him deep satisfaction to come from his retirement and take the chair, in July 1951, at a seminar called "Science in Australia", on the occasion of the fiftieth anniversary of the founding of the Commonwealth. The proceedings of that seminar have recently been published[1]. They contain addresses on the contemporary state of various sciences in Australia and a discussion on "A Scientific Policy for Australia". The addresses contain none of the complacency which the British (still deplorably out of touch with life in the Commonwealth) sometimes associate with their cousins in the southern hemisphere; indeed, some of them are refreshingly self-critical. There is only a pardonable minimum of self-congratulation; and it is abundantly clear that the Australian scientist is aware of the shortcomings of science in Australia and is resolved to overcome them.

For shortcomings there undoubtedly are. The most serious of them is a by-product of the very success of the C.S.I.R.; for the Council has so fostered fundamental research that it now has a near-monopoly of it. It is, of course, easy enough to improve on history after the event; but one cannot avoid the conclusion that if twenty-five years ago the Council had adopted a policy of co-operation with the universities, science in Australia would rest on much firmer foundations than it in fact does. Looking back on those days, one now realizes that the prime function of the Council was to establish a tradition for scientific research. The universities were doing very little. The State Governments were doing none. The Council had a choice of two ways of accomplishing its function. The quick way was to isolate itself from the universities with their swollen student populations, and from the States with their restrictive obligations to do remedial work for agriculture and industry, and to set up teams of research workers under good conditions in separate institutes. The slow way was to realize that good science can be done only by well-trained men, and accordingly to put resources into the universities, building up research units (as the Agricultural Research Council does in Britain) in close proximity to undergraduates. The Council for Scientific and Industrial Research chose the quick way. The result of this choice is that science in universities has been weakened by the Council, not strengthened; and as a consequence the training of scientists is incommensurate with the demand. The mere 'planting' of a C.S.I.R. Division near a university department (as has happened with the Soils Division in Adelaide and the Radio-Physics Division in Sydney) merely exacerbates the inequality of opportunity for research of a university lecturer compared with a C.S.I.R. officer. A more intimate integration of research and teaching was needed, and the continued absence of this led to the opinion (perhaps unjustified) among the universities that they had been 'let down' by the Council; at any rate, the Council has certainly suffered some embarrassment in recruiting Australian graduates, due directly to its long enjoyment of a monopoly in scientific research. In justice to the Commonwealth Scientific and Industrial Research Organization (C.S.I.R.O.), which is the new administrative form of the Council, it must be emphasized that a great effort is being made to repair these earlier omissions. In Sydney and elsewhere, units of the Organization are established in university departments, and they share in the teaching and in the direction of research.

A second shortcoming of science in Australia is that many of the large industrial firms have their headquarters in Britain and do all their important research there. Consequently, there is no body of industrial research in Australia to match its astonishingly rapid development of industry. As the writer of the introduction to "Science in Australia" says, "very few of the major companies, which are now well established, have paid more than lip service to research activities". This circumstance reflects upon science in universities, too; for the bright industrial scientist is impelled to look to the United Kingdom for a good job.

Finally, there is an impediment, rather than a shortcoming, to the development of science in Australia which it is our business in Britain to remove; and it is high time we removed it. The first-class Australian graduate has no sooner taken off his gown at the graduation ceremony than he has his eyes on

the sailing lists for Britain; and by one means or another most first-class science graduates manage to get to Britain. This is due to a combination of sentiment for 'home' and admiration for British science; and it is altogether admirable. But it is depressing for the Sydney or Melbourne professor who is trying to build up a research school. The time has come when exports of brains should be more nearly balanced by imports: for Australia has great opportunities to offer British graduates, especially in biology, geology, geography and anthropology. In equipment and laboratories its universities compare favourably with most in Britain. There is (contrary to the assertion of one speaker at the seminar) a new spirit of *esprit de corps* among scientists in Australia; and it is an invaluable experience for a young man to put in some years of research and teaching in the Commonwealth. On p. 132 of "Science in Australia" there is a rueful table complaining that only 30 per cent of lecturers in Australian universities have had overseas training. Is it too much to hope that the time may come when we in Britain criticize ourselves because only 30 per cent of our university lecturers have Commonwealth experience? This is no capricious musing. Upon that hope being fulfilled may depend the stability of the British Commonwealth.

[1] Science in Australia: proceedings of a seminar organised by the Australian National University on the occasion of the jubilee of the Commonwealth of Australia. Pp. xxxi+192. (Melbourne: F. W. Cheshire, 1952.) 30*s*.

BIRDS OF SCOTLAND

The Birds of Scotland

Their History, Distribution and Migration. By Evelyn V. Baxter and Leonora Jeffrey Rintoul. Vol. 1. Pp. liii+352+12 plates. Vol. 2. Pp. 353–763+14 plates. (Edinburgh and London: Oliver and Boyd, Ltd., 1953.) 63*s*. net.

THIS magnificent work, in two volumes, forms an outstanding contribution to the ornithology of the British Isles, and especially of Scotland. Both the authors are well-known personalities and life-long students of ornithology: they have watched and observed together for many years. Just as the work was published the sorrowful news was announced of the death of one of the authors—Miss L. J. Rintoul.

The information in the books is accurate and scholarly: it embraces records old and new, and painstaking research must have been needed to have gathered them together. It is not too much to say that this will be the standard work on Scottish ornithology for many years to come.

In the first volume there are chapters on Scotland, the factors which influence the bird life, the composition of Scottish avifauna, and migration. Next there is a description of the birds themselves, beginning with the Corvidæ, the first bird described being the raven.

The second volume begins with the swans and ends with the partridge. Each bird is sympathetically described: its past and present distribution are set down in detail, and the reader is thus given a clear picture of the species. Both volumes are packed full of interesting information. In the chapter on migration the importance of the bird-watching stations at Fair Isle and the Isle of May is pointed out. Among rare migrants to Scotland are the rock thrush, a brilliantly plumaged bird which nests no nearer than central France, the white-spotted bluethroat, the sub-alpine warbler, the dusky warbler, the pied wheatear, and (once) the needle-tailed swift.

One of the most sedentary birds, the crested tit, has long had its headquarters in the forests of natural Scots fir on the upper reaches of the Spey. It is remarkable, therefore, that it does not seem ever to have crossed the passes of the Cairngorm Hills until recent years and was unknown in the Forest of Mar, although the distance between the two forests is no more than fifteen miles. It is interesting how quickly a species can re-establish itself. The stonechat, which was entirely wiped out by the severe weather in the Isle of Skye in the early months of 1947, has now (1953) reappeared in precisely its old haunts. There is unusual information even of common birds. Who, for example, knows that a robin once visited the Observatory on Ben Nevis (4,406 ft. above sea-level) and that on April 12, 1925, another was found dead on the snow at the Pools of Dee, nearly 3,000 ft. above sea-level?

The authors think (Vol. 1, p. 237) that tarmac roads are connected with the decrease of the house martin in Scotland, and point to the fact that the cliff colonies (independent of road mud for their nests) maintain their numbers, whereas the house colonies have decreased. They record (p. 241) that thirty-six house martins on migration over Fair Isle roosted in the crevice of the rock, tightly packed one on top of the other. The record of a swift nesting on Lochnagar (3,768 ft.) is given in the book; I have sometimes doubted the accuracy of this record. Swifts often visit the Lochnagar precipices, but my own impression is that insect life is too uncertain for them to nest thus high. In the Swiss Alps I have seen swifts prospecting crevices at 7,300 ft. high, but they do not nest at that height. On p. 308 the increase of the buzzard in the Outer Hebrides is mentioned. That increase seems to have caused the hen harrier to disappear from its haunts here.

On p. 365 of Vol. 2 the valuable suggestion is made, to account for the disquieting decrease in the numbers of Bewick's swans as winter visitors to Scotland, that the species now winters in Holland in very much larger numbers than formerly. A great dam has caused the Zuyder Zee to become a vast and shallow freshwater lake, and several thousand Bewick's swans habitually winter here, feeding on the *Potamogeton* weed, which has established itself and spread. The record (Vol. 2, p. 467) of a gannet being killed on a wire fence at 2,300 ft. above Loch Hourn in western Inverness-shire makes me wonder whether there may be an occasional flight-line across Scotland from east to west in that district, for in mid-July 1952 I was astonished to see a gannet near Cluanie, at a height of 1,400 ft. above sea-level, gaining height in spirals preparatory to crossing the high hills in the direction of Loch Hourn. Yet the gannet is supposed never to be happy except when flying above the sea. The account of the northern golden plover, which has not been recorded as nesting in Scotland, reminds me that in 1925, on the Western Cairngorms, my wife and I began the construction of a hide at a golden plover's nest at 3,000 ft. The bird, very black in the breast, was, I believe, a northern golden plover; but mist and bad weather prevented us from completing the hide, or photographing the bird to obtain records of it. The description (Vol. 2, p. 731) of the ptarmigan

recalls that a few years before the Second World War the late Col. Balfour, of Dawyck, set ptarmigan eggs below a grouse on high ground on Upper Tweed, and the Duchess of Montrose made the same experiment on Goat Fell on Arran, where the ptarmigan at one time nested. Neither experiment was, I think, successful.

The two volumes are handsomely produced. There are two beautiful coloured frontispieces by G. E. Lodge and excellent photographs by Robert M. Adam, Eric Hosking and others.

No student of birds can afford to be without this work.

SETON GORDON

CHEMISTRY OF STARCH

Starch and its Derivatives

By J. A. Radley. (Monographs on Applied Chemistry, Vol. 11.) Third edition, revised. Vol. 1. Pp. xi+510. (London: Chapman and Hall, Ltd., 1953.) 65*s*. net.

THE appearance of a third edition of this monograph indicates that its usefulness is well established. Considerable advances have been made in starch chemistry since the second edition appeared in 1943, and this has necessitated large sections of the book being rewritten. The author has, furthermore, invited a number of distinguished collaborators —including several from the United States—to write the chapters in their own specialized fields of investigation. The subject-matter covered has thus been expanded while at the same time an authoritative point of view has been maintained; but two volumes now replace the original one.

As in previous editions, both fundamental and technical aspects of starch chemistry are covered. The general method of presentation has been retained. Each chapter tends to be a review article and there is inevitably some overlapping, although the book presents a uniform appearance. The list of references accompanying each chapter covers the literature to about the end of 1950.

The first volume is divided into two parts, of which the first deals with the structure, properties and reactions of starch, while the second covers amylases and their action. After a short historical introduction, there is an account by S. Peat of the enzymes involved in the synthesis and degradation of starch. This complex field is presented in a clear and concise manner. The fundamental chemical evidence for the structure of starch and its components is summarized in an excellent chapter by L. Hough and J. K. N. Jones. Physical properties such as swelling and gelatinization are also reviewed, with an emphasis on technical aspects. The longest and most complete chapter in the book is that on the starch fractions by T. J. Schoch. This provides a critical review of recent methods for separating, purifying and characterizing amylose and amylopectin. Many useful experimental data are incorporated. The physical properties of the two fractions are also discussed. In addition to an unusually long list of references (437, with the titles of the papers included) a cross-index of subjects is given. The significance of nitrogen and phosphorus in interpreting the behaviour of starch is next discussed; but little recent work is mentioned. An interesting account (by R. L. Whistler) of the phenomenon of retrogradation follows. A chapter discussing the hydrogen-bond by G. V. Caesar is followed by a review of the starch–iodine reaction. R. M. Hixon and B. Brimhall have written a chapter which reviews for the first time the chemistry of the waxy-cereals and starches.

The remainder of the first part deals with more technical aspects of starch chemistry. After a review on dextrins and dextrinization (G. V. Caesar), a comprehensive account is given by E. F. Degering of the preparation and physical and mechanical properties of the ethers and esters of starch. Inorganic and oxidized derivatives of starch are discussed by the same author. In Part 2, the preparation and mode of action of the amylases used in the starch industry are reviewed in a comprehensive manner with emphasis on the technical aspects.

The first volume of the new edition can be seen to incorporate much interesting new material, and should appeal to both the academic and industrial worker with an interest in starch chemistry.

E. L. HIRST

CULTURAL ANTHROPOLOGY

The Nature of Culture

By A. L. Kroeber. Pp. x+438. (Chicago: University of Chicago Press; London: Cambridge University Press, 1952.) 49*s*. net.

MAN can be viewed, as Prof. C. Lévi-Strauss has recently pointed out, either as a tool-making animal or as a social animal. In dealing with primitive man, one's view on this matter determines whether one is a cultural anthropologist (the predominant school in the United States) or a social anthropologist (foremost in Britain).

Prof. A. L. Kroeber, the doyen of American anthropologists, over half a century ago placed himself firmly among those who regard man's tool-making capacities as the basis for a scientific study of mankind. Since then, his copious, but always scholarly and polished, writings have added immeasurably to all the various fields of anthropology, but particularly to the idea of culture. Anthropology without Kroeber would be the poorer; cultural anthropology without Kroeber would indeed be poverty-stricken.

The present book is Prof. Kroeber's own editing of fifty of his articles and essays (some of them pared of extraneous material) centring around the notion of culture; each essay is accompanied by short "programme notes" of the circumstances of its composition, and the author's assessment as of late 1951. The essays are grouped into five sections of which the first and the last, "Theory of Culture" and "History and Process of Civilization", are of greatest general interest. The other three sections—"Kinship and Social Structure", "On American Indians", and "Psychologically Slanted"—are of equally great interest to the professional reader, but probably of less to the non-anthropologist.

Prof. Kroeber's appointed task has been the conceptual separation of culture from the organism, the psyche and society. Culture, to him, is "superorganic". Just as reducing organic phenomena to inorganic terms tells us a great deal about them, but makes us lose sight of the all-important idea of 'life', so reducing cultural phenomena to organic or psychological factors tells us a great deal about them, but makes us lose sight of their equally important and illuminating aspects which are specifically cultural. To watch this idea develop from the outcry of 1917 ("The Superorganic") against the followers of Herbert Spencer who see cultural evolution as a continuation

of biological evolution, to the long, thoughtful article of 1949 ("The Concept of Culture in Science") is to follow the development of one of the most provocative ideas of our day.

The section about history and process begins with the famous (1919) article on fashion, containing the germ of his subsequent idea of "styles", which develops into the notions of cultural intensity and climax which underlay his greatest work, "Configurations of Culture Growth". This concept of "styles" is turned and tended until it replaces to some extent the more atomically conceived "culture elements" and "culture traits" as the components, or bits, of culture. All these various threads are brought together in a short, final article dealing tantalizingly, if not exhaustively, with "The Novel in Asia and Europe".

Prof. Kroeber points out that, like all great ideas, the concept of culture was developed by many minds; we must add that one of the greatest and most stimulating of these minds is his own.

PAUL BOHANNAN

ENGINEERING MECHANICS

Mechanics

Part 2: Dynamics. By Prof. J. L. Meriam. Pp. xiii+341–671. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1952.) 32*s*. net.

THIS elementary work on dynamics is essentially a book for engineers. Its author's aim is to teach fundamentals with the aid of a large number of illustrative examples.

The book starts with prefaces addressed to (*a*) the student and (*b*) the instructor. The latter, with its discussion of the "natural learning process", should undoubtedly be read aloud with an American accent.

The introductory chapter, which is evidently common to Prof. Meriam's volumes on statics and dynamics, concerns certain fundamental ideas. These include mathematical and graphical description, "basic concepts" (space, time, force, etc.), scalars and vectors, Newton's laws, units, dimensions, accuracy and so forth. The author's intention is to build an arsenal of what information he considers necessary for the assault on his subject. But his choice seems a little ill-balanced. Some parts of his introduction read like a sermon (for example, that on graphical representation) while others appear to be rather difficult for a beginner (for example, that on dimensions).

Apart from this introduction, the book contains chapters entitled "Kinematics"; "Principles of Kinetics"; "Force, Mass and Acceleration"; "Work and Energy"; "Impulse and Momentum"; "Periodic Motion". The treatment of these subjects is simple and, although vector quantities are mentioned, the methods of vector analysis are not used to any great extent.

All the chapters except the introduction embody a large number of problems, some of which are worked out in the text. Answers are given to many. There are 662 of these examples (in a book of 330 pages) and most of them are well drawn from practical situations. It is the reviewer's opinion that these problems constitute a most attractive feature. There are two appendixes. The first deals with moments of inertia (and contains no fewer than seventy-two examples) and the second is a useful collection of data.

One or two topics are introduced which have not found their way into many comparable books. Cases in point are (1) the use of polar co-ordinates, and (2) motion "with variable mass". Both are undeniably welcome. Elementary gyroscope theory is introduced in the chapter on impulse and momentum and involves the use of vectors. It is unfortunate that, in a book which deals with Coriolis acceleration, no attempt is made to explain gyro theory after the manner of Inglis.

The collection of examples is excellent, and it alone would make this book a worth-while contribution. The main body of the text is of good quality. It is lucid and contains a large number of helpful diagrams.

R. E. D. BISHOP

ELEMENTARY ANIMAL ECOLOGY

Animal Ecology

By W. H. Dowdeswell. Pp. xv+208+16 plates. (London: Methuen and Co., Ltd., 1952.) 12*s*. 6*d*.

ALTHOUGH the subject of plant ecology has been reasonably well covered at different levels in a number of books, the subject of animal ecology has not received the same attention by authors, especially at the elementary level. This, in its turn, has contributed to the comparative neglect of the subject in schools. In this book, the senior biology master at Winchester College has sought to remedy the deficiency by providing a broad introduction to the ecology of animals which will not only cater for existing needs but will also stimulate further interest in animal ecology among sixth-form students in schools and first-year students at universities.

After a description of the range and purpose of animal ecology, the author examines the distribution of animals resulting from changing environment, colonization, isolation, specialization and seasonal change. Then follows an account of some general features of animal communities with particular reference to periods of activity and rest, food relationships and food chains, ecological niches, the size of animal populations, and animal movements. This is succeeded by examination of special animal forms like parasites, commensals and symbionts. Up to this point the book follows along stereotyped lines, its main virtue being that much of the information which is already available in students' text-books is here collected together to form a connected introduction to animal ecology.

The remainder of the book is made up of descriptions of animal communities including land, marine, estuarine and freshwater. For these the author can be warmly commended for accounts which will quicken interest in animal ecology among students who are just beginning their studies of the subject. They will receive some help from the chapter on practical animal ecology but would have profited even more if the author had omitted his trivial introduction to statistics and included some accounts of practical ecological studies which his own sixth-form students had carried out as well as suggestions for practical work of an experimental nature.

The book contains a useful bibliography and is illustrated with well-reproduced half-tone plates and line drawings.

T. H. HAWKINS

PROVISIONING EXPEDITIONS IN THE FIELD

SIR EDWARD MELLANBY opened a symposium, which had been arranged jointly by the Nutrition and Geographical Societies and was held on October 26, dealing with the provisioning of expeditions in the field. Sir Edward recalled the evolution of his own interest in this subject from that of the domain of pure science to the more humble but perhaps more practical realm of packaging!

The first paper, on emergency rations, was given jointly by Dr. G. R. Hervey and Prof. R. A. McCance and mainly concerned survival at sea. The authors have approached the problem from the physiological point of view. Even under the best conditions, a man requires at least one litre of water per day. Since he only has about forty-two litres of water in his body, and may be in a very bad way after losing seven litres, survival without water has a very definite time-limit. Food is much less important than water, except for its value for morale, for a man can live on his own tissues for weeks; indeed, food might be dispensed with altogether were it not for the fact that a small, relatively salt-free ration containing a little carbohydrate could materially reduce the output of salt and the destruction of tissue protein, and consequently for both reasons the volume of the urine and the water requirements.

Prof. McCance outlined a desirable, a compromise, and a minimum ration based upon water, boiled sweets, toffee, condensed milk and special biscuits. In practice, the rations necessary for the equipment of a life-raft must depend upon the length of time for which they are likely to be required, and the allowance of water, particularly, must be varied with the climatic conditions likely to be encountered. He concluded with a brief description of the new inflatable tented rafts which are being developed by the Navy, and pointed out that in them a man could create his own environment so that he could keep himself cool enough in the tropics to maintain his losses of water at or about the theoretical minimum, and survive in cold climates where he would die of cold and exposure in an open lifeboat.

Dr. H. G. Smith dealt with Army operational rations. These, he said, have now been standardized into five main packings, of which four differ only in respect to the number of men and the length of time for which they are designed. The fifth is an emergency ration consisting of four slabs of chocolate providing 860 calories. The principle in the Army is to give a soldier operational rations which rival the food he gets at the base camp; four of the rations supply two main meals and a snack meal, providing 3,000–4,250 calories a day. The food is packed in cans which only need heating. A ration consisting of bully beef and biscuits is a thing of the past.

With the increasing range of aircraft there is no means of telling whether an aircraft is likely to crash on land or sea, and Squadron Leader D. G. V. Whittingham pointed out that the rations required in the two cases are very different. The Royal Air Force emergency rations, which are carried under the ejector seat, are reckoned to be of less importance than the parachute, the dinghy, and wireless apparatus to facilitate location and rescue. Water is the prime consideration at sea and in the desert, and since the R.A.F. has to cover all climates and eventualities, the rations are carried in two parts. The "Universal Component" consists mainly of carbohydrate, and the "Land Mass Supplement" provides extra calories for a man travelling over land and perhaps requiring much exertion; this includes foods providing fat and protein as well as carbohydrate. It is assumed that water will be available for men who are using this supplement. Recent experiments suggest that such a ration may contain a high proportion of fat, so giving maximum calories for weight, and even if this leads to ketosis, this does not progress after the first few days and does not cause an appreciable degeneration in physical or mental performance.

The discussion was opened by Miss D. F. Hollingsworth, who described the products of the Ministry of Food's experimental plant for drying foods at Aberdeen. She was followed by Dr. A. Bombard, who made several interesting points on the basis of his practical experiences in crossing the Atlantic alone in an open craft. One was that survival at sea depends upon the will to survive more than anything else, and another was that although he had drunk sea water for the first few days of his voyage he would have died long since of this dangerous practice if he had done what had been attributed to him by the Press. His main concern had been to demonstrate the possibility of survival given no emergency rations at all. By spearing fish with a pen-knife, and drinking the juice, it was possible to survive for long periods of time, even if no food had been placed in the raft; but it had been the collection of rain water which had enabled him to survive his voyage across the Atlantic.

A lively discussion followed on the palatability (or otherwise) of dehydrated foods, and the meeting then adjourned for some practical nutrition in the shape of tea.

Prof. B. S. Platt was unfortunately ill, and Dr. R. H. Fox read the joint paper by himself and Prof. Platt on planning food supplies for tropical expeditions. Stability of body temperature in the tropics can only be maintained by sweating, and water requirements are high, but water can usually be obtained. Dr. Fox illustrated these physiological points by a diagram showing the various factors which contribute to thermal balance. He believes that in spite of its specific dynamic action, the diets should contain some protein to help to promote appetite, which is often rather poor in the tropics, even if men are working hard. Likes and dislikes are all-important in designing rations for a tropical expedition, because people tend to go without food when suffering discomfort from heat, rather than eat what they do not like.

Dr. L. G. C. E. Pugh opened his talk on nutritional aspects of Himalayan mountaineering by a description of the experimental work which has led to the belief that a high carbohydrate diet increases

a man's tolerance to great altitudes, and supported this by the experiences of people on earlier expeditions to great heights. In earlier Everest expeditions, climbers took an enormous store of luxury foods such as chicken in aspic; but they found when they got high up that they wanted something more ordinary, and often relied mainly on sugar and other carbohydrate foods. In general, diets have tended to get simpler and simpler, and local foods have been used extensively on some expeditions. In Dr. Pugh's opinion, however, curry and tea were overdone on the Cho Oyu expedition! He emphasized the importance of labelling the packages of foods clearly so that the climbers do not find themselves with nothing but potatoes to eat for several days on end—as once happened, and which he thought, with good reason, did not improve morale. On the recent Everest expedition, the average calorie consumption was 4,300 a day during the approach march and 3,900 at 19–22,000 ft. The food was all taken out from Britain, and it was packed in such a way as to make up seven different menus, each box being labelled with a day of the week. This proved to be a very successful arrangement right up to the Western Cwm. At very high altitudes men generally prefer carbohydrate above all else, and on this expedition the climbers were provided with 14 oz. of sugar a day and readily ate it. Special fancies were catered for, however, and on the final assault Hillary chose to eat sardines and biscuits. The loss of water from the lungs at high altitudes is four times as great as it is at sea-level, and Dr. Pugh emphasized the importance of an adequate supply of water. He pointed out that one of the causes of failure of some previous expeditions, the Swiss one for example, was lack of water. This year, better stoves and more fuel were taken to melt the snow, and the physiological degree of hydration had been virtually maintained.

Dr. G. C. L. Bertram dealt with the evolution of polar rations. Polar rations have always tended to be of the simplest type and appear very spartan and monotonous when compared with the rations which the Army sets out to provide to-day. Bertram emphasized that there has been some tendency in recent years to increase the number and variety of items carried on sledging journeys; but he considers that this is really unnecessary and that raising the standards of sledging rations tends to lead to dissatisfaction. Men who voluntarily undertake polar work, and who are working in a cold climate, can live on the simplest food day after day and enjoy it. He suggested that the importance of individual variation in calorie requirements is not generally appreciated; but there are psychological reasons for not differentiating between the big and small eater on these expeditions. It could, however, be satisfactorily done by issuing a supplement which would vary with the loss of weight. The fat content of the sledging ration is generally very high, and men may not like it for the first few days, but they soon get used to it. When expeditions relied upon human transport the weight of food carried for the men was a very important matter; but since the general adoption of dog transport, and still more recently of mechanical motor transport, the weight of the food required for the men has become less and less important because of the large amounts of food or fuel necessary for the dogs or tractors. For example, on a normal sledging expedition the ratio of the weight of the dogs' food to the men's food is 4–1, and a ratio of fuel to food on a tractor expedition would be even higher.

These papers were followed by a short discussion on the apparent difference between men's reaction to food in the tropics or at high altitudes as against polar regions. In the two former, they prefer to have nothing rather than eat what they dislike, even though they should be hungry; in extreme cold at sea-level, hungry men will eat anything. In spite of its taste and the difficulty some people find in getting it down, yeast was recommended by one speaker as a promoter of appetite, and the suggestion was made that it should be supplied at high altitudes. In an attempt to explain away the gargantuan appetite of the polar explorer, Bertram then rose and made the point that all polar rations now include yeast, and Mr. A. L. Bacharach brought the discussion to an end by remarking that in his experience a man who could eat yeast could eat anything.

MECHANISM OF PHOSPHORYLATION IN THE RESPIRATORY CHAIN

By Dr. E. C. SLATER

Molteno Institute, University of Cambridge

WHEN Belitzer and Tsibakowa[1] and Ochoa[2] found that more than one atom of phosphorus was esterified for each atom of oxygen consumed by respiring tissue preparations, they suggested that the phosphorylation must occur not only when the substrate was dehydrogenated, but also during the passage of the hydrogen atoms over the intermediate carriers to oxygen. This was demonstrated experimentally by Lehninger[3], who showed that phosphorylation accompanied the oxidation of reduced diphosphopyridine nucleotide by oxygen. In fact, it was shown that when β-hydroxybutyrate was substrate, all the phosphorylation occurred in the reaction between reduced diphosphopyridine nucleotide and oxygen, and none between substrate and diphosphopyridine nucleotide. With α-ketoglutarate[4], glyceraldehydephosphate[5] or pyruvate[6] (in certain micro-organisms only) as substrate, there is also phosphorylation linked with the initial dehydrogenation of the substrate. It is convenient to distinguish between oxidative phosphorylation of this type ('substrate-linked phosphorylation') and that associated with the further transfer of hydrogen atoms over the respiratory chain ('respiratory chain phosphorylation'). While considerable progress has been made in recent years with the elucidation of the mechanism of substrate-linked phosphorylation, little success has yet been met with in the case of respiratory chain phosphorylation. In fact, the particular hydrogen- or electron-transferring reactions in the respiratory chain which are associated with phosphorylation have not yet been identified. A detailed description of the mechanism of respiratory chain phosphorylation must await this identification. However, some recent findings have made it possible to suggest in general terms a mechanism in which the actual hydrogen-carriers are not specified.

Proposed Mechanism

The suggested mechanism is based on the following observations.

(*a*) In intact mitochondria, the passage of each pair of hydrogen atoms over the respiratory chain is coupled with the esterification of one, two or perhaps three atoms of inorganic phosphorus. The respiration appears to be compulsorily linked with phosphorylation[7], in the sense that inorganic phosphate and adenosine diphosphate are necessary for respiration.

(*b*) It is possible to obtain tissue preparations (for example, the Keilin and Hartree heart-muscle preparation[8]) which actively catalyse the aerobic oxidation of succinate or reduced diphosphopyridine nucleotide, without carrying out oxidative phosphorylation. Inorganic phosphate is not necessary for these reactions[8,9]. It has been suggested that these preparations consist of disrupted sarcosomal or mitochondrial membrane[10].

(*c*) A number of substances of widely different chemical structure can 'uncouple' phosphorylation from oxidation. In some cases (liver mitochondria[7], heart sarcosomes[11]), the rate of oxidation in the presence of inorganic phosphate, adenosine diphosphate, hexokinase and glucose is scarcely affected by the addition of a typical uncoupling agent, dinitrophenol; in the case of sarcosomes prepared from the flight muscles of the blowfly, the rate of oxidation is greatly increased[11]. The latter sarcosomes have an unusually low phosphorus to oxygen ratio.

(*d*) Some of the substances which 'uncouple' phosphorylation from respiration increase the rate of hydrolysis of adenosine triphosphate[12].

A common feature of the mechanisms of the substrate-linked phosphorylations (Racker[5]; Kaufman[4]) is that the dehydrogenated substrate is not immediately liberated, but remains bound to a grouping in the dehydrogenase molecule, from which it is freed by phosphorolysis reactions. In the present state of our knowledge, it seems worth while to see if the same general type of mechanism can explain respiratory chain phosphorylation. A mechanism along these lines is embodied in the following equations:

$$(1)\ AH_2 + B + C \rightleftharpoons A\sim C + BH_2$$

$$(2)\ A\sim C + ADP + H_3PO_4 \rightleftharpoons A + C + ATP$$

$$(3)\ A\sim C + H_2O \rightarrow A + C.$$

AH_2 and B are adjacent members of the respiratory chain and C is an additional component or grouping required for their interaction. A and C must be regenerated from the compound $A\sim C$ before hydrogen-transfer can proceed. In the intact mitochondria or sarcosome, this is brought about primarily by the transphosphorylating reaction (2), which leads to the esterification of inorganic phosphate. It is suggested that reaction (3) is relatively slow in the intact mitochondria, but can be greatly increased by dinitrophenol or other uncoupling agents. In this way, $A\sim C$ would be hydrolysed and be unavailable for the synthesis of adenosine triphosphate by reaction (2).

The idea that a compound like C mediates the conversion of the energy of an oxido-reduction into phosphate bond energy was first suggested in 1946 by Lipmann[13], whose mechanism may be described as:

$$AH_2 + C \rightarrow A + CH_2$$
$$CH_2 + H_3PO_4 \rightarrow CH_2.H_2PO_2\ (CH_2 \text{ is first dehydrated})$$
$$CH_2.H_2PO_2 + B \rightarrow C\sim H_2PO_2 + BH_2$$
$$C\sim H_2PO_2 + ADP \rightarrow C + ATP.$$

An essential difference between the two mechanisms is that in Lipmann's scheme phosphate enters before, and in the scheme described in reactions (1)–(3) it enters after, the formation of an energy-rich bond. The latter scheme is suggested by the work carried out since 1946 in a field largely opened up by Lipmann's discovery of coenzyme *A*.

Since phosphorylation occurs more than once during the passage of hydrogen atoms through the respiratory chain, more than one set of reactions described by equations (1)–(3) will occur, in which AH_2 and B are different. It is possible, however, that a common mediator C occurs in all sets of reactions. This would not be the case with Lipmann's mechanism, since the $C \rightleftharpoons CH_2$ oxidation-reduction potential must be suitably related to those of the $A \rightleftharpoons AH_2$ and $B \rightleftharpoons BH_2$ systems[13].

Equations (1) and (2) are probably the sums of a number of partial reactions, which are not specified in full, because it is impossible to choose between alternatives. For example, the intermediate in reaction (2) could be *A*-phosphate, *C*-phosphate, *A*-adenosine diphosphate or *C*-adenosine diphosphate.

Effect of Dinitrophenol

The uncoupling action of dinitrophenol is explained if it promotes the hydrolytic reaction of $A\sim C$, thereby decreasing the amount of the latter available for the phosphorolytic reaction.

The different behaviour of liver mitochondria and heart sarcosomes, on one hand, and of blowfly sarcosomes, on the other (see paragraph (*c*) above), can be readily explained in the following way. The high phosphorus to oxygen ratio of heart-muscle sarcosomes and the relative insensitivity of the ratio to treatments which affect the rate of hydrogen-transfer[14] suggest that reaction (2) can proceed much faster than reaction (1); that is, the regeneration of A and C from $A\sim C$ is not a rate-limiting step. The addition of dinitrophenol, by promoting reaction (3), will stop the esterification of phosphate; but since it increases the rate of a process which is not rate-limiting, it will not increase the rate of hydrogen-transfer to any extent. The low phosphorus to oxygen ratio of blowfly sarcosomes, on the other hand, suggests that reaction (2) is relatively weak. The rate of hydrogen-transfer will, therefore, be increased by increasing the rate of breakdown of $A\sim C$, for example, by the addition of dinitrophenol. It is also understandable on this basis why lower concentrations of dinitrophenol are required to uncouple phosphorylation with the blowfly sarcosomes than with heart-muscle sarcosomes[11].

The different behaviour of heart and blowfly sarcosomes to the addition of dinitrophenol could also be explained by Lipmann's mechanism, if it is assumed that dinitrophenol increases the rate of hydrolysis of $C\sim H_2PO_2$. However, the mechanism described by reactions (1)–(3) is more successful in explaining the discovery of Loomis and Lipmann[15] that dinitrophenol abolishes the requirement of respiration for inorganic phosphate, since in the presence of dinitrophenol respiration proceeds by reactions (1) and (3), which do not involve phosphate.

The stimulation of reaction (3) by dinitrophenol not only explains the uncoupling of phosphorylation, but also the stimulation of the rate of hydrolysis of adenosine triphosphate, since the back-reaction of equation (2), followed by a rapid reaction (3), would cause the hydrolysis of adenosine triphosphate. This idea is essentially that of Hunter and of Lardy and Wellman[12], except that they suggest a phosphorylated compound (corresponding to $C\sim H_2PO_3$ in the above formulation of Lipmann's mechanism) as the intermediate the hydrolysis of which is stimulated by dinitrophenol (see also Green[16]).

In considering the possible mechanism of the stimulation of reaction (3) by inhibitors of oxidative phosphorylation, it is necessary to take account of the wide range of substances of varying chemical composition which can act as inhibitors. This strongly suggests that most of these substances, if not all, act by a relatively non-specific mechanism. It is likely that the enzyme catalysing reaction (3) is present even in the intact mitochondria in the absence of inhibitors, but it may be inaccessible to $A\sim C$, and the inhibitor acts by making the enzyme and its substrate accessible to one another. An explanation of this type is supported by the fact that incubation of mitochondria or sarcosomes, which causes well-defined changes in the morphology of the granules, brings about a loss of respiratory chain phosphorylation; for example, that associated with the oxidation of succinate or β-hydroxybutyrate. This explanation would not exclude the possibility that some inhibitors of oxidative phosphorylation might react by a more specific mechanism, for example, by actual participation in reaction (3) (see Lardy and Wellman[12]).

Respiratory Chain Activity in the Absence of Inorganic Phosphate

The oxidation of succinate or of reduced diphosphopyridine nucleotide by the Keilin and Hartree heart-muscle preparation in the absence of inorganic phosphate can be explained in two ways: (i) during the preparation of these particles from the sarcosomes, the mutual accessibilities of the components of the respiratory chain are altered in such a way that reactions (1), (2) and (3) are replaced by the simple hydrogen-transferring reaction:

$$(4)\quad AH_2 + B \rightarrow A + BH_2;$$

or (ii) even in this preparation, C is necessary for the reaction between AH_2 and B, and the preparation also contains the enzyme catalysing reaction (3). This would mean that this hydrolytic enzyme is, like all the components of the respiratory chain, firmly bound to the insoluble portion of the sarcosome, which resists the disintegration treatment. However, the enzyme catalysing reaction (2) may be lost during the preparation.

While the first explanation is adequate for studies with the Keilin and Hartree heart-muscle preparation of hydrogen-transfer without accompanying phosphorylation, the second has the advantage that it eliminates the necessity of postulating that C is essential for the reaction between AH_2 and B in the intact sarcosome, but is not required in the disintegrated sarcosome, which still contains all the components of the respiratory chain firmly bound to the particles. It is simpler to assume that the reactions which are retained in the disintegrated sarcosomes follow the same course as in the intact sarcosomes.

In any event, reaction (4) does not take account of an important difficulty in any formulation of the mechanism of the respiratory chain. Although kinetic studies[17] suggest that the components react together by binary collision, the independence of the rate of reaction on the degree of dilution shows that the components are very firmly bound to the particles. This suggests that the mechanism may, in fact, be much more complicated than indicated by reaction (4).

Utilization of Respiratory Energy

An essential feature of the proposed mechanism is that the free-energy change in the reaction $AH_2 + B \rightarrow A + BH_2$ is not immediately liberated as heat, but remains chemically available in the compound $A\sim C$. Thus an essentially irreversible oxido-reduction reaction could become easily reversible. The energy in $A\sim C$ may either be utilized in reaction (2) to synthesize adenosine triphosphate, another reversible reaction, or be lost as heat in the irreversible hydrolytic reaction (3). But it would be unwise to assume that adenosine triphosphate is the only energy-rich compound which the cell can utilize. It is possible that $A\sim C$ might itself be used in some reactions. Woolley[18] has recently directed attention to the possibility of the utilization in the cell of energy-rich bonds, other than the pyrophosphate bond. If the $A\sim C$ bond can be used in this way, it is important to note that it can be formed in two ways, either by the respiratory chain reaction (1) without the intervention of phosphorus, or from adenosine triphosphate by reversal of reaction (2). This is exactly analogous to the case of acetyl–coenzyme A, the general acetylating agent in the cell. Acetyl–coenzyme A may be formed either by the oxidative decarboxylation of pyruvate in the complete absence of phosphorus[19], or by the reaction of coenzyme A, acetate and adenosine triphosphate[20].

If $A\sim C$ is concerned in certain energy-requiring processes in the cell, the reverse of reaction (2) might be a way in which adenosine triphosphate produced by fermentation or glycolysis could be utilized under anaerobic conditions by cells possessing the necessary enzymes. These processes would be expected to be prevented by any substance, for example, dinitrophenol, causing the breakdown of $A\sim C$. Thus, dinitrophenol would prevent the utilization, not the synthesis, of adenosine triphosphate. This would also be the case if the adenosine triphosphate formed anaerobically were utilized by another mechanism, since dinitrophenol causes its hydrolysis. Either of these possibilities might be the explanation of one puzzling action of dinitrophenol. It has been shown with extracts that the reactions in glycolysis or fermentation which bring about the formation of adenosine triphosphate are not susceptible to dinitrophenol[21]. Nevertheless, energy-requiring processes such as enzyme adaptation in yeast[22], or uptake of glutamate by *Staphylococcus aureus*[23], are inhibited by dinitrophenol, even under anaerobic conditions. On the other hand, the transport of ions by erythrocytes, a process also receiving its energy from glycolysis, is not affected by dinitrophenol[24]. This is understandable on the basis of the above explanation, since erythrocytes do not contain a complete respiratory chain, that is, they may not contain A.

The suggestion that $A \sim C$ might itself be used directly for certain energy-requiring processes raises the possibility that the energy of certain steps of the respiratory chain is normally utilized in this way and not via phosphorylation. The measurement of the yield of phosphorylation in respiration might not be a complete measure of the efficiency of utilization of the energy potentially available from respiration.

Conclusion

In conclusion, it should be emphasized that many of the features of the proposed mechanism are based on analogy with reaction schemes describing the participation of coenzyme *A* or the sulphydryl group of glyceraldehydephosphate dehydrogenase in substrate-linked phosphorylation which have recently been worked out by Racker[5] and Kaufman[4]. While there is no reason why similar reactions should necessarily operate in respiratory chain phosphorylation, the fact that the suggested mechanism offers possible explanations of some puzzling findings is some justification for believing that this might be the case. However, much more experimental evidence is required. It is obvious without considering any particular mechanism that the identification of AH_2 and *B* from among the comparatively few and well-studied components of the respiratory chain remains, an urgent task. But it could be important to recognize that a third substance might be required for their interaction. A fat-soluble substance is a possibility to be kept in mind, since about 40 per cent of the dry weight of the Keilin and Hartree preparation is phospholipid.

I wish to thank Prof. D. Keilin for his interest and advice. This work was carried out on behalf of the Agricultural Research Council. [Aug. 21.

[1] Belitzer, V. A., and Tsibakowa, E. T., *Biokhimiya*, **4**, 516 (1939).
[2] Ochoa, S., *Nature*, **146**, 267 (1940); *J. Biol. Chem.*, **138**, 751 (1941).
[3] Friedkin, M., and Lehninger, A. L., *J. Biol. Chem.*, **178**, 611 (1949). Lehninger, A. L., *J. Biol. Chem.*, **178**, 625 (1949). Lehninger, A. L., and Smith, S. W., *J. Biol. Chem.*, **181**, 415 (1949). Lehninger, A. L., *J. Biol. Chem.*, **190**, 345 (1951).
[4] Hunter, F. E., and Hixon, W. H., *J. Biol. Chem.*, **181**, 67 (1949). Kaufman, S., in "Phosphorus Metabolism", **1**, 370 (Johns Hopkins Press, Baltimore, Md., 1951).
[5] Warburg, O., and Christian, W., *Biochem. Z.*, **303**, 40 (1939). Racker, E., and Krimsky, I., *J. Biol. Chem.*, **198**, 731 (1952).
[6] Lipmann, F., *J. Biol. Chem.*, **155**, 55 (1944).
[7] Lardy, H. A., and Wellman, H., *J. Biol. Chem.*, **195**, 215 (1952).
[8] Keilin, D., and Hartree, E. F., *Biochem. J.*, **41**, 500 (1947).
[9] Bonner, W. D., *Biochem. J.*, **49**, viii (1951).
[10] Cleland, K. W., and Slater, E. C., *Biochem. J.*, **53**, 547 (1953).
[11] Lewis, S. E., and Slater, E. C., *Biochem. J.* (in the press). Slater, E. C., and Lewis, S. E., *Biochem. J.* (in the press).
[12] Ronzoni, E., and Ehrenfest, E., *J. Biol. Chem.*, **115**, 749 (1936). Lardy, H. A., and Elvehjem, C. A., "Ann. Rev. Biochem.", **14**, 1 (1945). Potter, V. R., and Recknagel, R. O., in "Phosphorus Metabolism", **1**, 377 (Johns Hopkins Press, Baltimore, Md., 1951). Hunter, F. E., in "Phosphorus Metabolism", **1**, 297 (1951). Lardy, H., and Wellman, H., *J. Biol. Chem.*, **201**, 357 (1953).
[13] Lipmann, F., in "Currents in Biochemical Research", p. 137 (Intersci. Pub., Inc., New York, 1946).
[14] Slater, E. C., and Cleland, K. W., *Biochem. J.*, **53**, 557 (1953).
[15] Loomis, W. F., and Lipmann, F., *J. Biol. Chem.*, **173**, 807 (1948).
[16] Green, D. E., *Biol. Rev.*, **26**, 410 (1951).
[17] Chance, B., *Nature*, **169**, 215 (1952). Slater, E. C., in "Biologie und Wirkung der Fermente", 4. Colloquium der Gesellschaft für physiologische Chemie, p. 64 (Springer-Verlag, Heidelberg, 1953).
[18] Woolley, D. W., *Nature*, **171**, 323 (1953).
[19] Korkes, S., Campillo, A. del, Gunsalus, I. C., and Ochoa, S., *J. Biol. Chem.*, **193**, 721 (1951). Korkes, S., Campillo, A. del, and Ochoa, S., *J. Biol. Chem.*, **195**, 541 (1952).
[20] Lipmann, F., Jones, M. E., Black, S., and Flynn, R. M., *J. Amer. Chem. Soc.*, **74**, 2384 (1952).
[21] Greville, G. D., and Rowsell, E. V., unpublished experiments (1949), quoted by Judah, J. D., *Biochem. J.*, **49**, 271 (1951).
[22] Spiegelman, S., *J. Cell. Comp. Physiol.*, **30**, 315 (1947).
[23] Gale, E. F., *Biochem. J.*, **48**, 286 (1951).
[24] Maizels, M., *J. Physiol.*, **112**, 59 (1951).

AUSTRALIAN COMMONWEALTH SCIENTIFIC AND INDUSTRIAL RESEARCH ORGANIZATION

ANNUAL REPORT FOR 1951–52

In the annual report of the Commonwealth of Australia Scientific and Industrial Research Organization, covering the year ended June 30, 1952*, material is arranged according to its subject rather than the Division or Section concerned. Expenditure during the year totalled £3,880,098, including £886,735 from sources other than the Commonwealth Treasury, notably £292,046 from the Wool Industry Fund and £420,423 from the Wool Research Trust Fund. Some progress is reported in the erection of new buildings, and the new laboratory for the Division of Tribophysics was expected to be ready for occupation early in 1953; several of the main buildings of the Sheep Biology Laboratory at Prospect, New South Wales, were almost ready for occupation, and reasonable progress has been made with buildings for the Wool Textile Research Laboratory at Geelong. A new series of publications dealing in non-technical language with various aspects of the Organization's sheep and wool research programme was initiated during the year and a new periodical, *Rural Research in C.S.I.O.R.*, was established to provide a summary of recent agricultural research and to stress its practical significance. Stress is also laid on the extent of collaboration with universities, and a large number of research workers are now engaged either in units established by the Organization in university buildings or in its own buildings on university property, in sections established to work in existing university laboratories with the professor as officer-in-charge, or on specific research projects for which the universities accept complete responsibility supported by funds supplied by the Organization.

Detailed surveys carried out by the Division of Soils covered 103,000 acres, and broad-scale surveys covered about 13,100 square miles in all States and in the Northern Territory, while a new soils map for Australia is being compiled and a manual of Australian soils is in the press. In soil chemistry a suitable potentiometer and amplifier were being assembled for assessing the hydrogen-ion status in suspensions of cation-dominant soils, while a simplified technique has been successfully applied to the determination of total exchange capacity in small samples of soils. Progress is reported in the chemical study of the inter-relationships of terra rossa and rendzina soils, and the study of soil chemistry of micro-nutrient metals was continued. A study was being made of the availability to the fungus *Aspergillus niger* of the metals iron, zinc, copper, manganese and molybdenum from finely ground rocks and unweathered materials such as are often found in the parent material of Australian soils, and the respiration of micro-organisms in deficient soils was being compared before and after the addition of trace elements, with the view of determining whether micro-organisms compete seriously with higher plants for such trace elements in deficient soils. A laboratory study of the effect of the impacting of surface layers of soil by heavy rain was in progress, as well as a study of the effect of a temperature gradient on the rate of

* Fourth Annual Report of the Commonwealth Scientific and Industrial Research Organization for the Year ending 30th June, 1952. Pp. 173. (Canberra: Govt. Printer, 1953.) 10*s.*

diffusion of water vapour in soils. A method has been established for determining field capacity by draining soil aggregates at a definite water tension.

During the year the international exchange of plants and seeds greatly increased, largely as a result of overseas plant exploration, more than three thousand samples being received from overseas and about seventeen hundred sent in exchange to forty-eight countries. Plant exploration in the Mediterranean region was continued, and a major collecting effort was made in Africa in search of suitable grasses and legumes for Queensland. A strain of *Sorghum* introduced from Brazil has shown promise as a fodder plant, and a study of the reactions of the resistant hybrids of the potato to the different viruses has indicated that resistance is due to the presence of virus-inactivating systems and not to hyposensitivity. Further studies of the persistence of both virus *X* and tobacco mosaic virus in tomato roots have been initiated to ascertain whether these viruses can continue to multiply in roots kept in darkness or are dependent on exposure to light. The results of a survey of a range of varieties of apples at two crop levels indicate that the keeping capacity of large-size fruit is most likely to be improved when manurial and cultural treatments designed to increase the size of the fruit increase the cell number per fruit without increasing the cell size. Soil sterilization experiments on soil infested with nematodes showed that satisfactory growth of apple seedlings could be obtained after treatment with D-D and formalin. The study of *Duboisia* spp. as sources of hyoscine and atropine, and of varieties of opium poppy as sources of opium alkaloids was being concluded. Samples of thirty-two substances obtained during the phytochemical survey of the flora of Papua and New Guinea were sent to the Sloan-Kettering Institute for Cancer Research for tests of anti-tumour activity.

At Canberra laboratory investigations on tobacco were continued, and at Ayr field investigations in association with the Queensland Department of Agriculture, while trials have been maintained with potassium, copper, zinc, molybdenum, manganese, iron, magnesium and boron on soils on the Southern Tablelands of New South Wales. Chemical examination has confirmed the identification of the degree of trashiness in uncured tobacco leaf determined by means of fluorescence; the trashy leaf does not fluoresce under ultra-violet light. In plant physiology work has continued on correlating the mechanism associated with, and controlling, plant development. Surveys of the distribution of skeleton weed (*Chondrilla juncea*) in relation to soil, climatic and land-use factors have been commenced. Rhizomatous grasses, such as Johnson grass and couch grass, have been successfully controlled with trichloroacetates at Canberra and Griffith, and screening tests on new herbicides were in progress at Griffith. With the object of obtaining a suitable grazing legume for wheat and sheep areas where conditions are unfavourable for subterranean clover, many annual medicks have been submitted to field trials, the most satisfactory results being obtained with a barrel medick (*Medicago tribuloides*) from Forbes, New South Wales, a burr medick (*M. hispida reticulata*) from Turkestan, and a short-spined variety (*M. hispida terebellum*) from Malta. A theoretical study of the movement of water into homogeneous unsaturated soils has been completed, and about 3,500 square miles of the 16,000 square miles to be covered in the ecological survey of the New England region have been mapped.

An experiment conducted at Perth involved a comparison of continuous and autumn-deferred grazing on a sown annual pasture with merino wethers, and the results of a long-term grazing management trial of the effect of light, medium and heavy rates of stocking Mitchell grass pasture at Cunnamulla, Queensland, were being prepared for publication. At the Kimberley Research Station the immediate objectives were to determine whether the Black Soil Plains of the Ord river are satisfactory for grazing and whether a stable system of agriculture can be devised.

Irrigation research is carried out principally at the Commonwealth Research Station, Merbein, Victoria, which is concerned chiefly with irrigation problems in the middle and lower Murray River valley, special attention being given to the growth-cycle of the sultana vine, and at the Irrigation Research Station, Griffith, New South Wales, where besides drainage and related soil problems in semi-arid and arid regions, soil fertility problems and horticultural problems, including factorial field experiments with citrus, are receiving attention. At the McMaster Animal Health Laboratory, Sydney, further trials with phenothiazine against *Haemonchus contortus* have confirmed that large particles greatly detract from the efficiency of the drug. Some seventy-two compounds were tested against *H. contortus* by injection into the rumen, and studies on the biological activity of complex ions prepared in the Chemistry Department of the University of Sydney indicated that their biological activity results from the poisoning of certain enzymes. At the Veterinary Parasitology Laboratory at Yeerongpilly, Queensland, studies of 'Queensland itch', an allergic reaction of the horse to the bites of a sandfly, a new species of *Culicoides*, were almost completed. At the Fleece Analysis Laboratory, Villawood, New South Wales, where 23,412 measurements were made during the year for the Division of Animal Health and Production, including yield determination, density, mean diameter, staple length and crimp, an economy of 50 per cent was effected in the use of detergents and in electric power for the large scour. The general research programme at the Poultry Research Centre, Werribee, Victoria, remained unaltered. The studies on cobalt deficiency in sheep, with the publication of maps showing the widespread distribution of cobalt deficiency in southern Australia, have led to the use of cobalt-containing licks as supplements for flocks, with a dramatic improvement in their general health and productivity. Experiments have been made to determine the relative efficacy of widely spaced dosing with quantities of cobalt greater than would be required for frequent administration, while the methods evolved for fighting the maladies arising from copper deficiency in sheep are now universally employed in the affected areas. Other studies relate to the effect of molybdenum on the copper metabolism of sheep, the nutritional physiology of cobalt-containing vitamin B_{12}, the processes of rumination, carbohydrate metabolism, chronic fluorosis, infertility and physiology of reproduction and energy metabolism. A series of complete energy-balances on sheep confined to rations of dried lucerne have established the fundamental law that the extra heat production which occurs on feeding is linearly related to the amount of combustible energy in the digestion products that are absorbed. Studies were continued on chronic copper-poisoning of sheep, on the resistance of sheep to nematode parasites, and on protection

against body blowfly strike, while work on cattle has included attempts to improve the toxicity of DDT to cattle tick, and studies on the loss of efficiency of benzene hexachloride dipping fluids, on the distribution of tick larvæ in a paddock and on the physiology of milk secretion.

The main emphasis in the work of the Division of Entomology is on the elucidation of fundamental facts about insects with the idea of finding weaknesses in the insect's defence where it can be most effectively attacked. Further progress has been made in elucidating the mechanisms involved in keratin digestion, and it has been established that keratin-digesting insects are characterized by the high reducing capacity of their mid-gut juices. Experiments with the sheep blowfly have shown that heavy destruction in certain circumstances leads to much higher population levels, although in other circumstances the population is reduced, and the definition of the conditions under which these effects are produced appears to be leading to conclusions of great practical importance. Relatively small field experiments indicate that the Argentine ant can be eradicated from residential areas by applying barrier sprays containing two per cent chlordane in the form of a grid over the area: treatment inside houses is unnecessary for complete control. A survey has been commenced of the distribution, seasonal incidence and relative economic importance of caterpillar pests of pastures and field crops in Australia. Investigations were continued on three strains of houseflies differing in susceptibility to DDT.

Fisheries research has included ecological investigations on an enclosed brackish-to-fresh lake on Moreton Island, Queensland, and on a partly enclosed area in Port Hacking, a full programme of investigations on the humpback whale, investigations on the racial relationships of salmon from Western and South Australia and Tasmania, on the alleged deterioration of trout fishing in Tasmania, on freshwater fish culture in Tasmania, on the microbiology of the inter-tidal estuary in relation to fish and oyster culture, and on pearl shell and oyster hydrology. A paper on the biology of the school shark was almost complete, and the plankton programme was redesigned to provide data to study the regional and temporal fluctuations of the composition, succession and relative abundance of the plankton.

Some of the work of the Division of Food Preservation and Transport was also concerned with chemical methods for estimating the spoilage of fish. A second paper has been published on the fundamental principles of canning processes, and an experimental survey of fruit cool stores in the deciduous fruit-growing areas of New South Wales, Victoria and Tasmania has been completed. An accurate and rapid method for determining nitrogen in the most refractory heterocyclic amino-acids has been devised, while polarographic methods have been used extensively in the investigation of the combination of amino-acids with heavy metals and in determining trace elements in canned foods. Microbiological investigations were concerned mainly with those environmental factors which affect the growth or death of food-spoilage micro-organisms, while the work of the new Plant Physiological Research Unit has helped to provide a background of the knowledge of the behaviour of cells and tissues required for the proper understanding of fruit and vegetable storage problems. During the past three years investigations have been directed towards finding the rate at which a pea crop matures, and there are preliminary indications that it will be possible to predict the weight of cut vines to be transported to the vining station and the yield of peas to be handled in the cannery. The maturometer, an instrument developed for the rapid measurement of maturity, has been patented and is now being produced commercially under licence. The use of fatty-acid esters, containing a paraffin chain of suitable length with a polar group at one end, in the cold-dip process for sultana drying has been further investigated, and further work has been done on the utilization of skim-milk solids by addition to bread, as well as on cheese starters and the flavour chemistry of Australian cheddar cheese.

The Division of Forest Products has identified more than eleven hundred timber specimens during the year, and has revised completely the card-sorting key developed to place timbers in their correct families or family groups. A preliminary study has been made on the removal of lignin and pentosan from *E. regnans* on alkaline pulping, and on the effect of temperature, time and concentration on the yield and permanganate number of the pulp. Two cationic urea formaldehyde resins gave satisfactory wet-strength development when applied to bleached and unbleached eucalypt kraft pulps. A detailed study has been made of the variation in shrinkage throughout a tree of *Eucalyptus regnans*, and much work has been done on the mechanical properties of radiata pine grown in Victoria. Tests with the high-pressure pilot cylinder have indicated that preservative treatment of the heartwood of eucalypt timbers is possible. Preliminary work to develop a standard laboratory technique for determining the resistance to decay of timbers has been almost completed as well as a study of the drying behaviour of twenty New South Wales and Queensland rain-forest species. Observations were made on the effectiveness of incorporating benzene hexachloride in casein glue for immunizing plywood against *Lyctus* borer damage, and interest was maintained in the utilization of waste wood.

In the Division of Building Research, where some cuts had to be made in the research programme, concrete investigations centred on foamed concrete made by the entraining process, while the study of the relation between the flow properties and the composition of oil-based caulking compounds continued with direct measurements of the flow properties of thick pastes. A study of concrete floor surfaces to determine the conditions necessary for concrete floors to be acceptable in domestic construction is almost complete, and a new mathematical treatment has made practicable the calculation of temperatures inside houses and other buildings exposed to fluctuating external temperatures. Polystyrene tiles installed three and a half years ago in kitchens and bathrooms are still giving good service, but bond failures are now extensive on all types of background where the filled drying oil–resin type of adhesive has been used.

A major objective of the work on wool textiles is to improve the competitive position of wool relative to synthetic fibres. Investigations in progress included the relationship of elastic properties to processing behaviour and 'handle'; the interaction between wool and water and its effect on mechanical behaviour; and elastic behaviour under loads insufficient to remove crimp. The molecular structure of proteins was being investigated by studies of the constituent α-amino-acids and lower peptides by

X-ray crystallographic and infra-red spectroscopic methods, while an examination of cultures of *Aspergillus oryzae* by paper chromatography and filter-paper electrophoresis has revealed many enzymes capable of attacking the products of cellulose degradation. Of moulds capable of initiating the breakdown of cellulose, *Stachybotrys atra* has been selected for intensive study. A detailed survey has been made of the scutching operation and the staff problems it involves in Victoria flax mills; considerable progress is reported in developing economical methods of utilizing short flax crops, and work has been continued on the identification and estimation of materials associated with the cellulose of flax fibre and their effects on the spinning quality of the fibre.

Besides its work on processing the titaniferous uranium ores of South Australia, the Division of Industrial Chemistry has been concerned with the utilization of the extensive deposits of high-grade rutile from eastern Australian beaches, the separation of thorium, cerium and the cerium group of lanthanons, the fundamental and applied aspects of dry-cell chemistry, the general mechanism of the cement-aggregate reaction, and the physical properties of fluids as affected by temperature and pressure; and applications have been filed for patents covering a process of separating antibiotics such as penicillin and streptomycin by counter-current extraction in which a solid absorbent of the antibiotic descends through a rising column of liquid which removes the contaminants. The *p*H gradient in the adsorption columns corresponds to the temperature gradient of a distillation column. A highly successful column partition chromatographic method has been developed for determining variations in the alkaloid content of the hepatotoxic *Heliotropium europaeum*, and a study of the rate of reaction of phenols and formaldehyde was continued. Tannin–formaldehyde adhesives for plywood which maintain their fluidity long enough for commercial requirements have now been obtained by first heating the tannin solution with sodium sulphite, while yields of more than 60 per cent of a tetramethyl dihydropyridine have been obtained from acetone and ammonia using an alkali catalyst.

The study of the flotation process has been continued, and satisfactory progress has been made in a comprehensive survey of the ignition and combustion characteristics of Australian coals with particular reference to the evaluation of coal for combustion. In the Division of Tribophysics advances are reported in our understanding of the distortions produced by plastic deformation, of phase changes in metals and of the mechanism of the slow combustion of hydrocarbons. Work is being done on diffusion on solid surfaces, and on the properties of surface films of long-chain compounds and of silicone lubricants. As during 1950–51, the work of the Division of Metrology has been directed largely towards meeting statutory requirements in respect of national standards. Some experience has been gained with the use of the geodetic base, and satisfactory progress made in the production of the working standards of mass. Development work has been continued on instruments and techniques for the precise measurement of engineering quantities such as force, pressure, stress and strain, angular speed, hardness and vibration, while the Division of Physics is likewise engaged in research designed to increase the precision of maintenance of standards and the measurement of basic physical quantities, particularly in temperature and photometry. Theoretical studies have also been made of electrical and thermal conductivity at low temperatures, and the efficiency of the helium liquefier has been improved. The Division of Electrotechnology, which forms part of the National Standards Laboratory, has also been investigating the dielectric properties of mixtures and of hydroxy compounds as well as the marked increase in conductivity of inorganic salts, minerals and some inorganic compounds when they are freshly ground.

Following the discovery in the United States of an atomic spectral line in the radiation from the galaxy, the Division of Radiophysics completed the first survey of these radio waves over the sky. A radio interferometer of thirty-two aerials was brought into operation and was being used for detailed observations of the sun, while, besides an extensive study of the effects of magnetic storms on the ionosphere, substantial progress has been made in work on the physics of rain and clouds and on the artificial production of rain. Statistical arguments in the Radiophysics Laboratory have established the existence of two classes of radio stars, and it has also been established that radio stars have angular diameters up to a degree. The development of the Division's microwave navigation system was virtually completed. Experiments on the measurement of the momentum and ionization of charged cosmic-ray particles were continued; the work on tracer elements has been reorganized and is now being carried out in a section of the Organization located in the Chemistry School of the University of Melbourne. In nuclear physics the main activities have been centred around the three particle accelerators and the cosmic-ray spectrometer. The 750-kV. high-current electrostatic generator was being operated continuously, and the 14-MeV. electron synchrotron became fully operational. The work on analogue instruments has been devoted mainly to operational use of the Organization's differential analyser, while work on electronic devices for use with digital machines has been concentrated on the development of the beam-deflexion type of high-vacuum tubes for carrying out logical binary functions.

PILTDOWN MAN

A CRITICAL re-examination of all the Piltdown specimens was undertaken this year by the British Museum (Natural History) in conjunction with the Department of Anatomy, University of Oxford. The results, published over the names of Dr. J. S. Weiner, Dr. K. P. Oakley and Prof. W. E. Le Gros Clark, demonstrate clearly that the jaw and the canine tooth are in fact deliberate frauds (*Bull. Brit. Mus.* (*Nat. Hist.*), **2**, No. 3; 1953). The Piltdown brain-case must still be regarded as a genuine fossil (an Upper Pleistocene variety of modern man). The jawbone and tooth which had been falsely associated with this human cranium were so entirely out of character that, even when allowance was made for different parts of the human skull having evolved at different rates, it became increasingly difficult as time went on to reconcile them with the evidence of human evolution obtained elsewhere. The removal of the 'ape-jawed Piltdown man (*Eoanthropus*)' from the fossil record thus actually clarifies the problem of human ancestry.

In their remarkably flat wear the molar teeth in the Piltdown jawbone resemble man rather than ape.

Microscopical examination of these flatly worn surfaces showed that they are due to artificial abrasion and not to natural wear. The canine is a young tooth with incomplete root, so the fact that it has been worn right down to the pulp cavity, as in an aged individual, is only explicable by artificial abrasion.

Re-determination of the fluorine content of all the specimens, using an improved technique, has shown that whereas the brain-case contains the same amount of fluorine as some local Upper Pleistocene fossils, the jawbone and the canine contain no more than modern specimens. The organic content of all the specimens has also been determined. The jawbone and the canine contain as much nitrogen as fresh bones and teeth ; but the brain-case contains only the small quantity expected in Upper Pleistocene fossils.

Finally, evidence has been found which indicates that the jawbone was artificially stained by iron salts and potassium dichromate prior to its being 'discovered' by the excavators. Some who were at first sceptical about the association of the human brain-case with an ape-like jaw and canine tooth became convinced that it was a genuine association, and not a fortuitous one, when it was announced that remains of another individual had been found at a second site. Tests applied to the two pieces of skull bone alleged to be from the second site show that whereas one piece is fossilized and probably belongs to the skull from the first site, the other piece is comparatively modern and has been artificially stained in an attempt to match it in colour. A molar tooth reputed to be from this second site shows signs of artificial abrasion and almost certainly came from the original 'Piltdown mandible'.

The tests and other investigations reported above were carried out jointly in the Departments of Geology and Mineralogy of the British Museum, in the Department of Anatomy and the Clarendon Laboratory, University of Oxford, and in the Department of the Government Chemist, London.

These investigations serve to confirm the doubts expressed by certain men of science during the controversy which raged for some years after the original discovery in 1912. For example, exactly forty years ago, Prof. D. Waterston, then professor of anatomy in King's College, London, after superimposing tracings of the radiograms of the Piltdown mandible and that of a chimpanzee, wrote (*Nature*, 92, 319 ; 1913) : "The similarity of the specimens brought out in this way is very striking, for the outlines are practically identical. . . . The cranial fragments of the Piltdown skull, on the other hand, are in practically all their details essentially human. If that be so it seems to me to be as inconsequent to refer the mandible and the cranium to the same individual as it would be to articulate a chimpanzee foot with the bones of an essentially human thigh and leg". A similar view was expressed by Mr. G. Miller, jun., in the United States after systematic comparison of the casts of the Piltdown fossils with the corresponding bones of men and apes.

OBITUARY

Dr. O. F. Hudson

Dr. Hudson, whose death occurred on October 8, had taken an early and prominent part in the development and application of the techniques of metallography and thermal analysis, and had made valuable contributions to progress, both as a teacher and by his researches, at a time when there were but few workers in this field.

Born in 1878, Oswald Freeman Hudson was educated at Alleyn's School, Dulwich, and entered the Royal College of Science in 1897, taking the associateship in chemistry in 1900. After a period at the Royal School of Mines, under Prof. Roberts-Austen, he went to the Mint as one of his research assistants. It was there that he had what was at that time the almost unique opportunity of acquiring experience in metallurgical research, under the guidance of the late Prof. W. H. Merrett. Work was then in progress for the sixth of the series of reports which Roberts-Austen had made to the Alloys Research Committee of the Institution of Mechanical Engineers during the preceding decade.

In 1902 the late Prof. Thomas Turner was engaged in planning and equipping the Metallurgical Department in the new buildings of the University of Birmingham, and Hudson went there as his lecturer in metallurgy. During the next fourteen years he devoted himself wholeheartedly both to teaching and to research. His work, chiefly on the copper–zinc alloys, and partly in collaboration with the late Dr. G. D. Bengough, appeared in the *Journal of the Society of Chemical Industry*. With the advent, in 1908, of the Institute of Metals, of which he was an original member, he became a regular contributor to the *Proceedings* and discussions of that body. He took a leading part in forming the London Local Section, and became the first chairman in 1921. The breadth of his metallurgical interests while at Birmingham is shown by the publication of a concise but admirable text-book on "Iron and Steel" in 1913, to which his friend Bengough contributed a section on corrosion.

In 1916, Hudson returned to London to collaborate with Bengough in the urgent work of the Corrosion Research Committee, sponsored by the Institute of Metals and under the chairmanship of the late Sir Harold Carpenter at the Royal School of Mines.

Two years later he was appointed metallurgist to the Admiralty Engineering Laboratory at West Drayton, Middlesex. There he remained until 1924, the nature of his work being confidential. Returning to Birmingham, he then assisted Dr. R. S. Hutton (now emeritus professor at Cambridge) in setting up the British Non-Ferrous Metals Research Association, afterwards transferred to the present buildings in Euston Street, London. As research superintendent he served this body for the next fifteen years, and was retained as consultant until 1944. During the Second World War he resumed his association with Prof. Hutton as a part-time lecturer at Cambridge and he also responded to a similar call for assistance at the Royal School of Mines.

Thus, over a period of more than forty years, Dr. Hudson had taken a prominent part in many new metallurgical developments and had witnessed the striking advances that have been made. His self-effacing modesty and natural gift for friendly collaboration had endeared him to a wide circle of fellow-metallurgists, who, either as former students or as colleagues, had profited by his guidance and help in their work.

S. W. Smith

NEWS and VIEWS

Mineragraphic Section of the Australian Commonwealth Scientific and Industrial Research Organization: Dr. F. L. Stillwell

Dr. Frank L. Stillwell has recently retired from his post as officer-in-charge of the Mineragraphic Section of the Australian Commonwealth Scientific and Industrial Research Organization after a long and successful career as a geologist and mineralogist mainly in the service of various government organizations in Australia. As a young graduate of the University of Melbourne, Dr. Stillwell was selected as a member of staff of the Australian Antarctic Expedition of 1911–14, and his studies of the metamorphic rocks encountered during that assignment attracted world-wide interest. Then for a time he was engaged on gold research and made notable contributions to geological thought concerning the origin of the Bendigo auriferous quartz reefs. In association with the Mines Department of New South Wales he contributed notably to knowledge of the Broken Hill Lode and the rocks of its immediate environment. Dr. Stillwell spent the years 1922–23 visiting South Africa, Europe and the United States. On return to Australia the application of newly acquired techniques in the investigation of opaque ore-minerals led him to reveal important economic considerations in the mechanical treatment of Broken Hill ores preparatory to smelting. He was then, in 1927, appointed petrologist to the Mineragraphic Research Section of the Council for Scientific and Industrial Research, now the Commonwealth Scientific and Industrial Research Organization. Since then his Research Section has developed, with marked efficiency, to great importance in the field of economic geology in Australia. His personal contributions have been many and his achievements widely recognized, culminating in the award by the Australian Institute of Mining and Metallurgy of its much-prized medal.

Dr. A. B. Edwards

Dr. A. B. Edwards, who succeeds Dr. Stillwell, graduated in the Department of Geology of the University of Melbourne and was awarded an 1851 Exhibition scholarship to continue his studies at the Imperial College of Science and Technology, London. His first major undertaking was an extensive petrological investigation relating to Victorian Cainozoic basalts, and this was followed by a notable contribution to the petrology of the Tertiary basalts of the Kerguelen Islands, dealing with material collected by the British, Australian and New Zealand Antarctic Research Expedition. On his return to Australia, Dr. Edwards was appointed to the Mineragraphic Laboratory as assistant to Dr. Stillwell, and there he has proved a most assiduous and able investigator in a wide range of problems undertaken in that Laboratory, contributing notably to mineralogical and petrological science in Australia. Among his major works in this connexion are field and laboratory studies of the great iron-ore deposits at Yampi Sound in north-western Australia and of the better-known iron-ore deposits of the Middleback Ranges in South Australia. Dr. Edwards now occupies a unique position among Australian petrologists and mineralogists.

Agricultural Research Council: Appointments

The Agricultural Research Council announces that Dr. R. Scarisbrick has been appointed to an additional post of scientific assistant to the Secretary of the Council. Dr. Scarisbrick, who will act as the Secretary's assistant in the fields of animal health and husbandry, will have the rank of deputy chief scientific officer. He will take up his new duties on January 1, 1954. Dr. Scarisbrick graduated in biochemistry and after a period of research work in Cambridge and at the Maudsley Hospital took his veterinary qualification at the University of Liverpool. His research experience includes work on the physiology of ruminants under the late Sir Joseph Barcroft and studies in pathological physiology in the former Institute of Animal Pathology, Cambridge. Since 1949 Dr. Scarisbrick has held the appointment of lecturer in animal pathology in the University of Cambridge School of Veterinary Medicine.

The Council also announces that Dr. E. E. Cheesman has been promoted to the grade of deputy chief scientific officer with effect from July 1. Prior to his joining the staff of the Council in 1949, as one of the scientific assistants to the Secretary, Dr. Cheesman was professor of botany in the Imperial College of Tropical Agriculture, Trinidad. He is responsible for advising the Secretary on matters affecting research on plants and soils. The mycological and entomological aspects of this work will continue to be the special responsibility of Mr. G. G. Samuel, also a scientific assistant to the Secretary and formerly chief plant pathologist at the Harpenden Laboratory of the Ministry of Agriculture.

University of Leeds

Dr. S. Mackey is on leave for a year from his lectureship in the Department of Civil Engineering, University of Leeds, to go as professor of civil engineering at the Indian Institute of Technology at Kharagpur. The University has received the following gifts: renewal of £750 a year for a further two years to the Department of Pharmacology from the Wellcome Research Laboratories and £315 to the Department from Boots Pure Drug Co., Ltd., Nottingham; renewal of £600 a year for a further seven years from Turner and Newall, Ltd., Manchester, for Fellowships in engineering, inorganic chemistry or physics.

Atomic Energy Development

In reply to questions in the House of Commons, on November 9, Mr. Duncan Sandys, and on November 10, the Prime Minister, affirmed the Government's readiness to welcome collaboration in the field of atomic energy on a reciprocal basis with the Government of the United States; but Mr. Sandys pointed out that the Atomic Energy Commission of the United States continues to be precluded by legislation from any effective exchange of information on these matters. In reply to further questions on November 10, the Prime Minister said that he would have the possibility of treating the development of atomic energy for industrial purposes as a Commonwealth matter rather than primarily as a domestic matter studied by the Departments concerned.

Replying to questions regarding uranium deposits, Mr. Sandys said that the most promising region in Great Britain for uranium discoveries is in Cornwall. Pockets of uranium ore occur there; but the quantities so far found would not justify the expense of mining and treatment. The Government's decision to rely on uranium deposits overseas is therefore not a question of policy, but of necessity.

Expenditure of the Department of Scientific and Industrial Research

In a written answer to a question regarding the expenditure of the Department of Scientific and Industrial Research, on November 12, Mr. J. A. Boyd-Carpenter, Financial Secretary to the Treasury, agreed that there had been some slight fall in real expenditure of the Department in 1952–53 compared with 1951–52 and 1950–51. The 1953–54 estimates for the Department, however, provided for an increase of about £400,000 over the 1952–53 level, and a general understanding had been reached between the Department and the Treasury which provided for the gradual expansion of the Department's activities over the next five years.

Analytical Abstracts

The Society of Public Analysts and Other Analytical Chemists has provided abstracts of the literature on analytical chemistry for readers of *The Analyst* ever since the journal was first published in 1876. For the past four years these abstracts have been prepared by the Bureau of Abstracts and supplied to members of the Society and to subscribers to *The Analyst* under the title *British Abstracts C*. The Bureau will cease to exist at the end of this year, and *British Abstracts* will no longer appear in its present form. The Society has therefore decided to issue a new publication, to be called *Analytical Abstracts*, which will cover the whole range of analytical literature in the same way as did *British Abstracts C*. *Analytical Abstracts* will be edited by Dr. Norman Evers and published for the Society by W. Heffer and Sons, Ltd., of Cambridge. It will be published each month in a format similar to that of the abstracts included in *The Analyst* prior to 1950 and will be available in the new year to members of the Society and to subscribers on the usual terms; it will also be sold separately at 50*s*. a year, including the index, or at 60*s*. a year, printed on one side only, without the index.

Journal of Protozoology

The Society of Protozoologists is to publish a new *Journal of Protozoology*, beginning in the spring of 1954. Papers concerned with original work on any aspect of the study of Protozoa may now be submitted to the editor, William Trager, Rockefeller Institute for Medical Research, 66th St. and York Ave., New York 21, N.Y. The journal will consist of four issues a year. The annual subscription will be 9 dollars for all except graduate students, for whom it will be 6 dollars. Inquiries regarding subscriptions and membership of the Society of Protozoologists should be addressed to Norman D. Levine, Secretary, College of Veterinary Medicine, University of Illinois, Urbana, Illinois.

Ammonia Assimilation by *Chlorella*

P. J. Syrett (*Ann. Bot.*, N.S., **17**, 65, 1; 1953), in a study of the assimilation of ammonia by nitrogen-starved cells of *Chlorella vulgaris*, has observed that the addition of ammonium sulphate to the culture solution is followed immediately by the rapid assimilation of ammonia and a notable increase in the respiration-rate. This continues until all the ammonia has been assimilated or until some carbon reserve within the cells has been used up. The ammonia is converted into soluble organic nitrogenous compounds, free or combined α-amino-nitrogen or amide-nitrogen during the initial phase of the experiment. Later a smaller proportion of the assimilated ammonia is found in these fractions while appreciable quantities of basic amino-acids are formed. With this assimilation there is an increase in the rate of oxygen absorption and carbon dioxide liberation, the value of the respiratory quotient decreasing. Non-reducing sugar and acid-hydrolysable polysaccharide are rapidly metabolized. Possible explanations of these several phenomena are discussed in some detail. An explanation along the lines that the addition of ammonia to nitrogen-starved cells, which leads to the synthesis of amide, may result in the increased utilization of a substance such as adenosine triphosphate, and hence in an increased respiration-rate, is favoured.

East African Agriculture and Forestry Research Organization: Report for 1952

The report for 1952 of the East African Agriculture and Forestry Research Organization is the first to be issued by the Organization from its new headquarters at Muguga, Kenya. In spite of the unrest in Kenya, considerable progress has been made and three new sections—namely, forest entomology, soil microbiology and soil physics—were opened. The first of these is undertaking a general survey of forest insects and investigating methods for preventing damage from the Cerambycid beetle, which causes serious losses in the exotic plantations of Kenya. Questions of nitrogen supply form the initial programme of the soil microbiology section, while the work of the soil physics department will be based chiefly on soil moisture problems as they affect both agriculture and forestry. In this connexion the recent survey carried out by Dr. C. R. Hursh, of the Southeastern Forest Experiment Station, United States Forest Service, on forest management in East Africa in relation to local climate, water and soil resources, is of special interest. In his report he instances cases where excessive felling of high forest has reduced the mist regarded as desirable by tea growers, and of land deterioration through faulty management of water supplies or overgrazing, and stresses the need for technological development of the results of scientific research if the remaining natural resources of the country are to be safeguarded. The sectional reports show that a healthy co-ordination is in operation both between the various departments within the East African Agriculture and Forestry Research Organization itself, and also with other neighbouring research organizations.

Quartz Clocks of the Greenwich Time Service

A general account of the development of the quartz clocks of the Greenwich Time Service, from the time of the installation of the first quartz clock in 1939 up to the present time, is given in a paper by H. M. Smith (*Mon. Not. Roy. Astro. Soc.*, 113, 1; 1953). It is nearly ten years since the quartz clock completely displaced the pendulum clock in the

fundamental work of the Greenwich Time Service, and it has now attained a high standard of reliability. Introduced at first in the Greenwich Time Service as long-term standards, their high stability over periods of two or three years has made it possible to use them for determining the nature of the annual fluctuations in the rotation of the earth. It is worth noticing that the periods of uninterrupted run, given continuity of power supplies, may extend over several years, as has been the case with some of the clocks mentioned. Failure of crystal oscillators is very rare—in six years since the Abinger clocks were transferred to battery operation there has been only one failure of a crystal oscillator.

Index of Theses for Higher Degrees at British Universities

In a paper prepared for presentation to a conference of the Association of Special Libraries and Information Bureaux which was to have been held at Nottingham during September 1939, Colonel Luxmoore Newcombe discussed the accessibility of British university theses and the need for more information about such theses, and went on to raise the question of the feasibility of compiling and publishing a national guide to such theses. Fourteen years later, as a result of discussions of a joint subcommittee appointed early in 1950 by the Library and Information Committee of Aslib and the University and Research Section of the Library Association, this suggestion has come to fruition in a new serial publication of Aslib, "Index to Theses Accepted for Higher Degrees in the Universities of Great Britain and Ireland" (Vol. 1, 1950–51; pp. xii+157. London: Aslib, 1953; 25*s*., or 21*s*. to members). This first volume, which is edited by P. D. Record, covers the academic year 1950–51, except for the University of London, where entries are based on the calendar year 1950. The material has been supplied by the Secretary to the Committee of Vice-Chancellors and Principals, and the Index covers theses accepted by universities in England, Wales, Scotland, Northern Ireland and the Republic of Ireland. Information on availability is summarized in a table appended to an editorial note, and an introduction is contributed by Mr. J. H. P. Pafford. The present volume covers 2,182 theses, and the entries are numbered serially and arranged by subjects, the author's name being given first, followed by the title and the degree for which it is given. The author's university is indicated by an initial letter or letters in parentheses, following his name. An index of authors and a subject index are provided; but the latter, like the classification of the entries, as the editorial note emphasizes, is subject to the hazards and limitations imposed by the absence of any other information as to content beyond that supplied by the titles of the theses.

Radio Instruments and Preferred Valves

The firm of Marconi Instruments, Ltd. (St. Albans, Herts), has recently published a bound catalogue describing and illustrating a large variety of its instruments for those engaged in telecommunications and allied industrial applications. This catalogue is the first of an annual series, and it supersedes the loose-leaf versions which have been issued by the company during the past few years. Among the new instruments described in the present volume are: a series of portable absorption-type frequency-meters covering the range 250–4,000 Mc./s.; a very-high-frequency test set, comprising a signal generator covering frequencies 60–200 Mc./s., power meters for audio and radio frequencies, a radio-frequency field detector, and a multi-range D.C. test meter; and a useful oscillator providing a signal power of about 10–50 mW. over the frequency-range 2,100–3,750 Mc./s. Most of the instruments shown in the section on "Television and Radar Test Equipment" are new, and they include a test set for the 3-cm. band (9,000–9,680 Mc./s.), and a spectrum analyser and noise generator for the 10-cm. band (2,900–3,150 Mc./s.). In order that users of this catalogue may keep up to date with developments in measuring technique, a useful bulletin entitled "Marconi Instrumentation" is issued at frequent intervals and may be obtained on request.

Another most useful publication, which has recently become available, is a booklet entitled "List of Preferred Valves", which has been issued by the Scientific Instrument Manufacturers' Association (20 Queen Anne Street, London, W.1). This comprises in tabular form details of the types and characteristics of a series of valves which, it is believed, will meet most of the needs of those engaged in the scientific instrument industry. The list is divided into two categories—standard-sized valves and miniature valves—and details of the base-connexion arrangements for each type are included.

"Life in A.D. 2000": Royal Society of Arts Bicentenary Competition

The Royal Society of Arts will reach its bicentenary in March 1954, and as part of the celebration of this event the Society is organizing an essay competition with prizes of £250, £100, £50 and ten of £10, making a total of £500. The general subject for the essays is: "The Practical Aspects of Life on this Earth in the Year 2000", and individual competitors are required to submit their forecasts of a single aspect of life at that period related to arts, manufacture or commerce. Entries may be in written or be in visual form (drawings or models, with any necessary explanation in writing); in the former case they must be typewritten and in English and must not exceed three thousand words. The competition is open to all persons of British nationality and Fellows and Associates of the Society of whatever nationality. Competitors must complete an entry form by February 15, 1954, and must submit their essays by June 30. Further details can be obtained from the Secretary, Royal Society of Arts, John Adam Street, Adelphi, London, W.C.2.

History of Regional Farming in Britain

The Association of Agriculture and the British Agricultural History Society are arranging a one-day conference to discuss regional history with special emphasis on the agricultural background, to be held at the Institute of Education of the University of London, Malet Street, London, W.C.1, at 10.30 a.m. on December 5. The first paper will be a general one on "Regional Farming in England", by Dr. W. G. Hoskins. The afternoon session will be devoted to three short papers on "The Farming Regions of Lincolnshire", by Mrs. I. J. Thirsk; "The Rise of Sheep Farming with the Great Enclosures in North Wales", by Prof. R. Alun Roberts; and "Farming Regions with Special Reference to Wiltshire", by

Dr. E. Kerridge; each paper will be followed by discussion. The conference fee will be 5*s*. (2*s*. 6*d*. to members of either of the two organizing bodies). Applications should be sent to the General Secretary, Association of Agriculture, 238–240 Abbey House, 2 Victoria Street, London, S.W.1, or to the Secretary, British Agricultural History Society, Museum of English Rural Life, 7 Shinfield Road, Reading, Berks, from whom further details can be obtained.

Radioisotope Conference at Oxford

A Radioisotope Conference, arranged by the Atomic Energy Research Establishment, Harwell, is to be held in Oxford during the week July 19–24, 1954. This will be similar to a Conference arranged by Harwell in 1951 in Oxford, which was also on these peaceful uses of atomic energy, and was attended by more than five hundred delegates from Britain and many countries overseas. Great progress has been made since then in the use of radioactive isotopes, and the forthcoming Conference will deal solely with developments in recent years. It will discuss methods and results obtained using radioisotopes in all fields of science. On the first three days of the Conference, papers presented will deal with applications in medicine, biology and agriculture. The remainder of the meetings will be concerned with chemical, physical, engineering and general industrial applications. In medicine it is the intention to deal with experimental rather than routine uses. An exhibition of instruments and techniques of interest to radioisotope users will be held in Oxford during the Conference. The printed proceedings will be published, if possible, before the end of 1954. Further details and application forms can be obtained from the Conference Secretary, Atomic Energy Research Establishment, Harwell, Didcot, Berks.

Christmas Lectures for Young People

At the Royal Institution, 21 Albemarle Street, London, W.1, the 124th course of six lectures "adapted to a juvenile auditory" will be given by Mr. J. A. Ratcliffe, of the Cavendish Laboratory, Cambridge, on December 29 and 31, 1953, and January 2, 5, 7 and 9, 1954, at 3 p.m. The general title of Mr. Ratcliffe's lectures will be "The Use of Radio Waves", and he will deal respectively with radio waves and their use for communication; position-finding by radio; radio searchlights and telescopes; radar; the ionosphere; and radio astronomy. The fee for the lectures will be £1 (£2 for adults) and application for tickets should be made to the Royal Institution at 21 Albemarle Street, London, W.1. The Institution of Electrical Engineers (Savoy Place, London, W.C.2) has arranged for Dr. J. H. Mitchell to give a lecture at 3 p.m. on December 31 and again on the following afternoon. Dr. Mitchell will talk on "Electricity through Gases". Admission to the lecture, which is free, can be obtained by writing to the Institution at the above address.

The Night Sky in December

New moon occurs on Dec. 6d. 10h. 48m., U.T., and full moon on Dec. 20d. 11h. 43m. The following conjunctions with the moon take place: Dec. 2d. 04h., Mars 7° N.; Dec. 3d. 12h., Saturn 8° N.; Dec. 4d. 21h., Mercury 7° N.; Dec. 5d. 10h., Venus 5° N.; Dec. 19d. 23h., Jupiter 3° S.; Dec. 30d. 23h., Mars 7° N.; and Dec. 31d. 02h., Saturn 8° N. In addition to these conjunctions with the moon, the following conjunctions with bright stars occur: Dec. 7d. 02h., Mars in conjunction with Spica, Mars 3·5° N.; Dec. 12d. 07h., Venus in conjunction with Antares, Venus 5·2° N.; and Dec. 16d. 09h., Mercury in conjunction with Antares, Mercury 5·4° N. Mercury is a morning star, rising at 5h. 45m. and 6h. 40m. on December 1 and 15, respectively, but later in the month it is too close to the sun for favourable observation. Venus, a morning star, rises at 6h. 25m., 7h. 10m. and 7h. 45m. at the beginning, middle and end of the month, respectively, but at the end of the month this occurs about twenty minutes before sunrise; the stellar magnitude of the planet is −3·4; 0·97 of the illuminated disk is visible at the beginning of the month, and practically the whole towards the end of December. Mars, a morning star, rises about 2h. 55m. throughout December; early in the month it is fairly close to θ Virginis, and towards the end of the month it is near κ Virginis. Attention has already been directed to its conjunction with α Virginis on Dec. 7d. 02h. Jupiter rises in the afternoon and is visible throughout the night, stellar magnitude −2·3. At the beginning of the month it is close to ζ Tauri, from which it slowly moves westward, and on December 13 it is in opposition. Saturn, a morning star, rises at 4h. 30m., 3h. 40m. and 2h. 45m. on December 1, 15 and 31, respectively. In the early part of the month it is a little south of κ Virginis, from which it gradually recedes in an easterly direction during the remainder of the month. Occultations of stars brighter than magnitude 6 are as follows, observations being made at Greenwich: Dec. 1d. 6h. 05·1m., *q* Virg. (*R*); Dec. 11d. 18h. 31·9m., λ Capr. (*D*); Dec. 24d. 23h. 36·3m., 83 *B* Leon. (*R*). *R* and *D* refer to reappearance and disappearance, respectively. The Geminid meteors, radiant near α Geminorum, are active during December 11–13. Winter solstice occurs on Dec. 22d. 04h.

Announcements

H.R.H. the Duke of Edinburgh has graciously consented to accept honorary membership of the Institution of Mining Engineers.

The theme for the next annual meeting of the Société de Chimie Physique, to be held in Paris during June 8–12, 1954, will be "The Structure and Texture of Catalysts". Those wishing to read papers should submit a short résumé before January 15 and the text before March 15, so that they can be printed and circulated in advance of the meeting. Further details can be obtained from the secretary-general, Prof. G. Emschwiller, École Supérieure de Physique et de Chimie, 10 rue Vauquelin, Paris 5e.

Errata. In the communication entitled "Birefringence and Elasticity in Keratin Fibres", by Dr. R. D. B. Fraser, published in *Nature* of October 10, p. 675, it is incorrectly stated that birefringence values could be reduced to a common density by use of the factor $\sqrt{\rho_0/\rho}$; this factor should be ρ_0/ρ. The expression used for calculating birefringence gives only a partial correction for density variation. Line 12 should read ". . . in birefringence during extension . . ."; and the legend to the graph should read ". . . 30 per cent and 50 per cent extensions of human hair".

INTERNATIONAL CO-OPERATION IN AFRICAN BOTANY

SOME seventy members and guests of the Association pour l'Étude Taxonomique de la Flore d'Afrique Tropicale held their second plenary meeting at Oxford during September 29–October 3. The full text of the scientific papers read will be published in Florence in the journal *Webbia*, under the editorship of Prof. R. E. G. Pichi-Sermolli. The following is a brief account of some of the more important results.

After the introductory address of welcome by the president, Mr. A. W. Exell (British Museum, Natural History), Dr. W. Mullenders (Brussels) read a paper on "The Phytogeographical Elements and Groups of the Region of Kaniama (High Lomami – Belgian Congo)". He stated that it is possible to analyse floras according to the phytogeographical groups represented: first, the basic element characteristic of the region dealt with; secondly, connecting groups characteristic of two or several regions; thirdly, pluri-regional groups (palæotropical, pantropical and cosmopolitan); and fourthly, endemics. Dr. Mullenders on this basis made an analysis of the flora of the region of Kaniama (841 species), using the phytogeographical territories established by Lebrun. He found that 31·3 per cent (263 species) belonged to the Guinean element and 31·4 per cent (264 species) to the Sudano–Zambesian element. Plants of the connecting groups comprise 15·3 per cent (129 species); endemics 1·7 per cent (14 species); and species widely spread 20·3 per cent (171 species). The connecting groups showed a decided bias in favour of the Guinean region. The Guinean element was highest in the wetter grass communities and lowest in the dry grass communities, and conversely with the Sudano–Zambesian element. Degradation by fire led to reduction of the Guinean element, while absence of human interference favoured the development of equatorial forest, with, of course, a high proportion of Guinean species. The climax is thus mainly represented by the Guinean element, but the impact of man tends to favour Sudano–Zambesian species. The Kaniama district is thus to be placed in the Guinean region, though close to the boundary of the Sudano–Zambesian region.

Dr. Hugh Scott described and vividly illustrated an adventurous journey to northern Ethiopia, particularly the mountainous High Simien, during November and December 1952, mainly to study the insect fauna of high elevations. His route was from Asmara across the Tacazzé River to Debárec and thence to the High Simien, Gondar and Lake Tana. He visited Mt. Buahit (14,796 ft.) and Ras Degien (15,154 ft.), the highest peak in Ethiopia. On the latter, *L. rhynchopetalum* and the spiny *Helichrysum citrispinum* were characteristic of high altitudes. Here true snow occasionally falls; but Dr. Scott only encountered frozen hail. Among other plants illustrated were tree-heath, bamboo, a giant *Echinops* and *Kniphofia*. The only giant lobelia was *L. rhynchopetalum*, the hollow stems of which are used as trumpets; *L. giberroa*, so abundant in parts of central and southern Ethiopia, and also in Eritrea, was not seen. The top of the plateau of the High Simien has been mostly cleared, but juniper trees around churches give evidence of its original vegetation. No *Podocarpus* was seen.

Dr. J. Léonard (Brussels) directed attention to the difficulties encountered in interpreting large heterogeneous genera—whether to maintain them and at the same time perpetuate bad taxonomy, or to put them in order by making them homogeneous. In order to divide heterogeneous genera, it is necessary to take into account the hierarchy of characters, to study all the species, and to assess the correlation of characters, which may be primary characters derived from the morphology of the flower, or secondary characters which are vegetative and often minor but nevertheless most useful. Good genera should have correlation between primary and secondary characters. Genera with primary characters only are doubtfully valid, and with secondary ones only even more suspect. Where secondary characters are in opposition within a genus, it may imply the existence of overlooked primary ones. He emphasized the need of uniformity in the treatment of genera.

Species of the savannah and miombo are often extremely variable and thus to some extent subjective, while in forest species there is, on the other hand, a tendency to fixity of characters, thus making the species objective. Bad taxonomy and a mixture of species is often implied by a very variable forest species, or by geographical or ecological discontinuity. Dr. Léonard gave examples in the genera *Guibourtia* and *Afzelia*. He finally emphasized the need for systematists to study all available material of a group.

Prof. P. Duvigneaud (Université Libre, Brussels) then discussed "La Géographie des Caractères et l'Étude de la Flore Africaine", with special reference to the Soudano–Zambesian region. When the flora of this region was being first described, there was little material available, and in some groups further collections have served to link up the earlier described species in a remarkable way, so that to-day certain species prove to have a range of variation much greater than was originally thought possible. He went on to analyse geographically this range of variation in certain groups, notably in *Erythrina*, *Diplorrhynchus* where six described species were shown to be referable to only one with geographical sub-species, and the suffruticose species of *Cryptosepalum* where there is a quite extraordinary range of variation. He contrasted these genera with others where similar characters have proved to be not only quantitative but qualitative as well and have served to define good species. Prof. Duvigneaud went on to discuss the reasons for the extraordinary range of variation found in some groups, suggesting that it might be due to past climatic changes and introgressive hybridization favoured by a uniform topography. He emphasized the necessity of examining the entirety of material of a species before deciding upon the limits of its variation.

The morphology of the African species of *Loranthus* was considered by Mlle. S. Balle (Université Libre, Brussels). In the African continent some three hundred species are found, belonging to thirty-two well-characterized groups or sections. The morphological characters of taxonomic importance are mainly derived from the flowers, which show a wide range of structure, the perigone being either gamo- or poly-petalous, mostly zygomorphic, but sometimes actinomorphic, with 4–7 segments; the stamen filaments may be erect, reflexed or curled, with or without a tooth, and may show thickening above.

The morphology of the style also varies. Mlle. Balle compared the characters of groups represented in Africa and those represented in Asia and Oceania. She then analysed the distribution of the different sections in different territories in Africa according to their degree of evolution, finding that the most primitive sections are poorly represented or absent in West Africa but much better represented in East Africa. She finished by posing the problem of whether to maintain *Loranthus* as a single genus or to split it up into a constellation of smaller genera.

Mr. F. White (Imperial Forestry Institute, Oxford) then discussed "The Distribution of some African Species of *Diospyros*", the largest and most widespread genus of the Ebenaceae, agreeing with the rejection of *Maba* as a distinct genus. Though *Diospyros* grows in every territory and climatic zone of Africa except the very driest, he presented evidence to indicate that it is essentially a forest genus. He also directed attention to the concentration of species in the coastal forests of East Africa, where fourteen species occur of which eleven are endemic; nine of the latter have no close affinity with other species of tropical Africa, though two are very closely related to West African species. He gave further examples of vicarious species in East and West Africa.

In a paper on "Pollen Morphology and Taxonomy of Certain African Plants", Prof. G. Erdtman (director of the Palynological Laboratory, Stockholm) showed for the first time some electron micrographs of ultra-thin sections (200 A. thick) of pollen grains and spores prepared by a special technique, mainly developed by Dr. Sjöstrand (Stockholm). He then went on to describe various instances among African plants where pollen morphology gives valuable support to taxonomic views already expressed, or makes new suggestions which the taxonomist must consider. The validity of the following families, Dioncophyllaceae, Ctenolophonaceae and Barbeyaceae, is thus confirmed. Other suggestions were that Canellaceae may be related to the Magnoliales; that *Pentadiplandra* has pollen similar to that of Capparidaceae, but not to that of the Olacales; that *Jollydora* is anomalous in Connaraceae; that *Craterogyne* is distinct from *Trymatococcus*; that *Choristylis* and *Itea* have similar pollen and may constitute a separate family; that *Roussea* and *Ribes* have fairly similar pollen grains; that *Kirkia* is anomalous in Simaroubaceae; and that an affinity for Thymelaeaceae is to be sought among the crotonoid genera of Euphorbiaceae. Prof. Erdtman finally directed attention to the recently formed International Commission on Palynology and asked that polliniferous or sporiferous material of species of new genera, sub-genera, etc., should be sent to him when they are described, in return for a diagnosis of the pollen grains or spores.

Dr. R. A. Maas Geesteranus (Rijksherbarium, Leyden) discussed two features concerning the lichens of Kenya. *Xanthoria parietina*, common in the northern hemisphere in nitrogenous or maritime habitats, is also found in North Africa, at the Cape and in a few stations in Kenya at about 2,000 m. altitude, which may be connected with neighbouring soda lakes the dust of which is often widely dispersed by wind. His second topic was the development of lichens in the bamboo zone and the way in which they colonize old bamboo stems, starting at the internodes with crustaceous species, which can survive on atmospheric moisture and retain it, and are then followed by foliaceous and fruticose species. The internodes are ultimately invaded from the nodes.

The nomenclature of the vegetation zones on the mountains of tropical Africa was considered by Prof. A. S. Boughey (University College, Achimota), who pointed out the extraordinary duplication of names given by different authors for the same community, and emphasized the need for some uniform system. He suggested a division into zones rather than belts —since the latter imply too much spatial continuity— using floristic differences as a basis, delimited by differences in altitude. He proposed the following six zones: lowland, 0–800 m.; foothills, 800–1,500 m.; highland, 1,500–2,100 m.; montane, 2,100–3,000 m.; temperate, 3,000–4,500 m.; and mountain desert, above 4,500 m. He finished by comparing these proposed zones with those used by Prof. C. G. G. J. van Steenis in Malesia.

Prof. L. Hauman (Brussels) read a paper, "Sur la Nécessité de distinguer une Région afro-alpine pour la Végétation africaine". The high mountains of East Africa are equatorial, and thus the temperatures of their high altitudes are uniformly low. Their high altitudes are isolated climatically and poor floristically, but what plants there are are often remarkable, for example, the giant senecios and lobelias. The genera include many that are temperate but apparently none endemic. Continual cloud causes a great richness of bryophytes. Prof. Hauman proposed to consider the vegetation from the zone of giant lobelias and senecios upwards as constituting the Afro-alpine Zone, lying above the sub-alpine zone of heath-forests.

Dr. O. Hedberg (University of Uppsala) dealt with "Some Taxonomic Problems concerning the Afro-alpine Flora", commenting that no allowance for range of variation was made when species were described in the past. By graphical methods he showed continuous variation in such genera as *Sebaea* and *Swertia*, resulting in the reduction to synonymy of numerous species previously considered distinct. In these genera, he said, the idea of vicarious species inhabiting different mountains in tropical Africa has been pushed too far on insufficient evidence. He then gave examples of wide variation within one species shown by *Senecio keniophytum* and *Helichrysum citrispinum*. He also pointed out that insufficient allowance has been made for hybridization, which certainly occurs among the genera *Senecio* and *Lobelia*, and gave a graphical analysis of hybrid populations between two herbaceous species, *Senecio mattirolii* and *S. transmarinus*, demonstrating that certain previously described species are, in fact, elements of a hybrid swarm between these two. He finally announced that he is engaged on a complete revision of the alpine flora of the East African mountains.

Mr. J. B. Gillett (Royal Botanic Gardens, Kew), who has recently returned from southern Ethiopia, considered the relation between the highland flora of Ethiopia and that of Kenya Colony, with reference especially to recent statements that the Ethiopian highlands form a different phytogeographical region from those of East Africa. Mr. Gillett divided a sample of the flora of the southern margin of the Ethiopian highlands into four groups, as follows: (*B*) plants confined to Ethiopia south of 10° N.; (*AB*) plants also found in the highlands of British East Africa; (*BC*) plants found in northern Ethiopia; and (*ABC*) plants found in all three areas. The totals are: (*B*), 10; (*AB*), 41; (*BC*), 12; and (*ABC*), 112.

These figures indicate that the flora of the southern Ethiopian highlands is more closely related to that of the British East African highlands than to that of northern Ethiopia, in spite of the formidable obstacle to the spread of highland plants now presented by the low arid country of northern Kenya.

In a paper on "Some Aspects of the Vegetation of Ruwenzori", Mr. R. Ross (British Museum, Natural History) gave some observations made on the recent expedition to Ruwenzori of which he was a member, discussing particularly the zonation of vegetation. He recognizes the following zones: 1,200–2,100 m., *Pennisetum* savannah. 2,100–2,600 m., montane forest: probably complex, much affected by climatic and biotic factors—for example, elephants. 2,600–3,100 m., bamboo zone: divisible into four topographical types, two characterized by Ericaceae, thus simulating the true ericaceous zone higher up. 3,100–3,300 m., *Rapanea-Hagenia* forest: a tree lobelia and senecio occur. 3,300–3,900 m., ericaceous zone: *Philippia longifolia* forest dominant, mostly about 10 m. high, sometimes less; a bog vegetation of tree senecio and lobelia occurs, to be distinguished from similar communities higher up. 3,900–4,800 m., alpine zone: a mosaic of *Alchemilla* heath, *Helichrysum* scrub and tree senecio forest; these may be intermingled where the soil is continually wet. Above 4,800 m., glaciers.

Mr. Ross particularly noticed a repetition at different altitudes of communities similar in appearance but floristically different.

J. P. M. Brenan

GENETICS AND PLANT PATHOLOGY

THE breeding of resistant strains offers a valuable means of reducing the loss of production caused by disease in our domestic plants; but if his work is to be efficient and successful the breeder must enjoy the co-operation of the plant pathologist. A welcome opportunity for a joint discussion of their common problems was provided for pathologist and breeder at the meeting of the British Mycological Society held at Birkbeck College, London, on October 16. The subject was "Genetical Aspects of Plant Disease" and the chair was taken by Dr. C. J. Hickman.

In the introductory paper, Prof. K. Mather sketched in the nature of the host–disease relation from the genetical point of view. Host and pathogen are in permanent conflict: resistance in one puts a selective advantage on virulence in the other, while virulence in its turn puts a premium on new resistance. The situation is seen almost diagrammatically with bacteria and their phages. Exposure to the phage will select out the few resistant mutants from a colony of susceptible bacteria. The resistant colonies grown from these will in their turn select out mutants with new powers of attack from the, to them, otherwise innocuous phage; and so on. In bacterium and phage these changes are attributed to fresh mutation, but in higher plants and fungi a store of variation exists as a permanent feature of populations and species, both in the wild and in domestication. The variation affects properties of resistance and pathogenicity as well as all the other characters, morphological and physiological, of the plant, so that the selection of new mutant forms of the crop or virulent strains of the disease need not wait on the chances of mutation.

The mode of storage of the variability and its availability to selection depend on the system of variation of the species. In crop plants it may exist within varieties where cross-breeding is the rule, or between varieties of inbreeders, or in wild relatives of the domestic species. The breeder may draw on any of these for the raw materials of improved resistance. The systems of variation in fungi are less well understood; but there can be little doubt that variation for pathogenicity is common in the wild. The variation may be stored by genic balance within nuclei and released by sexual recombination, or it may be hidden by balance between nuclei in heterokaryons and released by sorting out in asexual spore production. The reaction of the fungal population in producing new pathogenic strains to the introduction of resistant host varieties must clearly depend on the system of variation. A fuller understanding of these systems in fungi is therefore a prime requisite for an adequate programme of breeding for disease resistance.

Mr. E. W. Buxton then gave an account of his investigations into the variation of *Fusarium oxysporum*, the imperfect fungus which causes the yellows disease of *Gladiolus*. Variation was observed in respect of both morphological characters and pathogenicity in cultures of the fungus isolated from diseased *Gladiolus* plants. Although some mutation appears to occur, it is too infrequent to account for the variation to be seen in the cultures, which must therefore have been present in the original isolates from the host plants.

While the older cells of the hyphæ generally contain but one nucleus, the tip cells have an average of seven nuclei, and anastomoses are common between adjacent hyphæ. Thus all the requirements for the formation of heterokaryons are present, and heterokaryons can indeed be readily synthesized in experiment. The nuclear ratio of a heterokaryon has been shown to vary characteristically with the carbon content and carbon/nitrogen ratio of the medium on which it is grown, adjustment to the medium taking place in a matter of a few days. There can be little doubt that heterokaryosis is an important factor in the storage of variation for morphological characters, and that it has complicated the taxonomy of this fungal group. Though there is less experimental evidence about variation in pathogenic properties, such variation undoubtedly occurs in the wild and it appears to be uncorrelated with the morphology of the fungus. Heterokaryosis may well be important also in regard to these pathogenic properties, and a number of questions, such as whether the hyphæ in the soil and those which invade host tissues are heterokaryotic, suggest themselves for further study.

The third paper, by Mr. P. R. Day, also dealt with an imperfect fungus, *Cladosporium fulvum*, which is a serious pest of the tomato. Three resistance genes are known in the tomato, so that 2^3 physiological races of the fungus can be distinguished by all-or-none tests of infectivity. Of the eight possible races, seven have been recognized in Canada and five of these have been found in Britain. The fungus may be heterokaryotic but inoculation tests have so far proved inconclusive and the controlled synthesis of a heterokaryon has yet to be achieved. Marker mutations have been induced in the fungus by irradiation but, perhaps for technical reasons, no mutation affecting pathogenicity has yet been found, even though loss

mutation could bring about specialization should immunity of the host spring from a reaction induced in it by the attacking fungus. The radiation-induced markers were used to follow the effects of competition in a susceptible host between races of the fungus differing in their levels of host specialization. It has been claimed that, in the blight fungus, races with wider host ranges have lesser virulence—a relation which would be of great importance in the conservation of variation in natural populations—but the results with *Cladosporium* were not fully consistent. Mr. Day concluded by suggesting the growing of genetically mixed stands of host plants to control the spread of the disease fungus.

The remaining two papers took up the story from the point of view of the host crop. Dr. H. W. Howard described work on breeding potatoes for resistance to disease, especially late blight. In first reviewing the general considerations which the plant breeder must have in mind, Dr. Howard pointed out that a decision must be taken as to which of the many diseases must be given pride of place in the breeding programme; that sources of resistance must be sought within the crop itself and in wild relatives; that some knowledge of the genetics of resistance is valuable, though it need not be precise; that easy methods of testing resistance are desirable even though not essential; and that a knowledge of variation in the pathogen is essential but may not come along until resistant varieties of the host plant are available.

Cultivated potatoes differ quantitatively in their degrees of attack by late blight (*Phytophthora infestans*). The related species, *Solanum demissum*, is field immune in Great Britain, though it suffers from blight attacks in its native Mexico. Up to now blight resistance has been sought by the transfer of major genes for resistance from *S. demissum* to the potato. These varieties of potato with new properties of resistance, however, tend to go down under the attack of new physiologic strains of the fungus showing the specialization necessary for the successful attack of the new varieties. Indeed, where mixed stands of potatoes have been grown, they have served to reveal the simultaneous presence of all the strains of fungus necessary to attack the host plants with their various types of resistance. Thus the variation for pathogenicity is present in the natural population of the fungus, perhaps as a simple mixture of genetic types, perhaps in heterokaryons. Immediate mutation can scarcely account for the presence of the many strains, for although occasional mutation of type has been seen in culture, the fungal strains are in general stable in respect of their pathogenic properties. But whatever the way in which these fungal strains appear, the future of the *demissum* type of resistance in potato breeding is far from certain: it may have to be reinforced, or even replaced, by selection of the quantitative type of resistance found in *tuberosum* itself.

The fifth and last paper of the meeting was a fascinating account of his work in breeding strawberries resistant to the red core fungus, *Phytophthora fragariae*, by Mr. R. D. Reid. When the breeding work was started it was not even known with certainty that red core was due to a *Phytophthora*. With the isolation and description of the fungus by Dr. Hickman, the first great step forward was taken. Mr. Reid then described how he had sought for sources of genetic resistance, how these had been found despite many disappointments and difficulties, and how the resistance had been combined with good plant characters; how specialized races (of which some ten have now been identified at least tentatively) have appeared in the picture, and how the search for sources of genetic resistance is still going on with the aim of using them to keep the strawberry ahead of the fungus. Again the question, as yet unanswered, of the origin and rise of the new strains of fungus is at the centre of the breeder's problems.

Discussion was opened by Mr. G. G. Samuel, who began by pointing out the great economic importance of breeding for disease-resistance. Biffen's wheats and Reid's strawberries, for example, show what immense rewards can result from successful breeding—at least for the grower if not for the breeder. Great needs still exist: the breeding of potatoes able to stand up to the root eelworm could, for example, save up to £2,000,000 a year in the potato crop of Britain. Genetics—in the present connexion fungal genetics, particularly Jinks's study of heterokaryosis—is now coming to the aid of the breeders seeking to produce disease-resistant types, and it promises to be an ally of the utmost value. But, despite the breeding successes of the past, are we working on the necessary scale? Where we now work in thousands, should we not think in terms of, and plan for, tens and even hundreds of thousands of seedlings annually, as do breeders in some other countries? Should we not aim at a bigger effort? A general discussion, ranging over such diverse topics as the genetical requirements of mycologists, technical aspects of assessing disease resistance and methods of controlling the spread of new pathogenic strains of fungi, then concluded the meeting.

K. Mather

RECRUITMENT FOR THE CIVIL SERVICE

REPORT OF THE COMMISSIONERS FOR 1949–52

At the Universities and Industry Conference organized by the Federation of British Industries at Ashorne Hill in October 1952, Sir John Maud expressed the view that, although the Civil Service requires a larger proportion of first-class graduates than it has been having, it is probably in the national interest that more, at any rate, of those of marginal first-rate standard should go into industry or trade rather than into the Civil Service. The report of the Civil Service Commissioners for the period April 1, 1949–March 31, 1952*, suggests that this may now be happening. At the beginning of the period the Commissioners did not find enough candidates of good quality for the administrative class. Although afterwards there was no difficulty in filling the vacancies—about sixty each year—throughout the period, they were unable to fill all the vacancies in the senior branch of the Foreign Service and in the special departmental classes (mainly inspectors of taxes), in which there were more posts to be filled than before the War. The Commissioners have formed the general impression that the number of outstanding candidates who wish to join the Home Civil and Foreign Services is smaller than it used to

* Report of Her Majesty's Civil Service Commissioners for the Period 1st April, 1949, to 31st March, 1952. (Being the Eighty-Fifth Report of the Commissioners.) Pp. 61. (London: H.M.S.O., 1953.) 2s. net.

be. Throughout the period they were unable to fill all the available posts in the scientific classes, and for most of the period all the growing requirements of departments for the professional engineering and analogous classes could not be met. The biological field was the only one in which the number of good candidates was larger than the number of vacancies; but even here all the posts could not be filled since some of them required specialized ability and training. The general standard of the candidates accepted was good; but there were not enough of really first-class quality suitable for the most exacting kinds of original work.

The system of continuous recruitment, previously tried and now adopted in all competitions for the senior scientific officer and scientific officer classes, under which candidates could apply at any time during the year, has been extended to the recruitment of professional engineers, surveyors and architects, with a consequent improvement in the position; and by further substantial salary increases and raising the upper age-limit to sixty, a sufficient number of good candidates was attracted by the beginning of 1952 to fill the reduced number of posts available, apart from those for quantity surveyors. Evidence of the diminished appeal of the Civil Service to the scientific worker or technologist is to be seen, however, in the figures given for the competitions for the scientific classes for 1949–50 and 1950–51. During the former year there were some 211 applications for 30–40 posts as senior scientific officer, of whom 115 were interviewed or examined and 40 were accepted. For 1950–51 there were 262 applications for 77 posts, but only 109 were interviewed and 51 accepted. For scientific officers the trend is the same: during 1949–50, 1,196 applications for 265 posts, 745 interviewed and 285 accepted; during 1950–51, 610 applications for 398 posts, 338 interviewed and 158 accepted; and during 1951–52, 212 applications for 85 posts, 97 examined or interviewed and 59 accepted.

There is as yet little evidence on which to judge the value of the new selection methods for the administrative class. The details of the place of education and the university degree of successful candidates for the administrative class in the Home Civil Service and the senior branch of the Foreign Service during 1949–52 indicate that the new methods have made little difference to the social structure of the Service. A wide range of public and grammar schools is represented; but few schools provide more than one entrant a year. In the Foreign Service, Oxford and Cambridge are much more dominant among the universities in providing recruits than they are for the Home Civil Service. This wide distribution of schools providing candidates is possibly encouraged by the depreciation inseparable from the expansion of officialdom; but relatively lower salaries, overwork and a belief which is encouraged, for example, by Treasury parsimony on pension adjustments, that the State is a poor, if safe, employer, may well be important factors in lowering the attractiveness and prestige of the Civil Service.

The Commissioners' report includes one example of official dilatoriness which indicates the seriousness of such factors. In 1949 the Government decided to create a small new general-service class of information officers, and during 1949–50 some 279 candidates were interviewed and 242 appointed. A special competition to fill 80–90 posts in all grades of the class was announced in June 1951. About three thousand applications were received, and 466 candidates were interviewed. "It has not yet been possible," states the report, with unconscious irony, immediately in front of a paragraph dealing with psychologists, "to announce the results of this competition, since the future of the Information Service has come under further review."

INTERNATIONAL SCIENTIFIC ABSTRACTING

THE Abstracting Board of the International Council of Scientific Unions came into existence officially on June 1, 1952, but its activities first began about November 1951. A report on its activities to date was presented by the secretary of the Board, Prof. G.-A. Boutry, to the Executive Committee of the International Council of the Scientific Unions for its meeting at Strasbourg during July 9–10, 1953, where the Abstracting Board was itself to meet for the first time. Dispersion of the members of the Board throughout the world has caused some delay without seriously impeding the activities of the Board, apart from secretarial embarrassment, which is likely to persist until the subventions allocated to the Board permit at least one meeting in the year.

A major result achieved by the Board and noted in this report is the formal acceptance of the decisions of the United Nations Educational, Scientific and Cultural Organization and the Royal Society regarding authors' summaries by all periodicals printing papers on physics and published in the United States, the Netherlands, Belgium, France, Italy and, with a few exceptions, the United Kingdom. The Board has also requested the publishers of the more important periodicals printing papers on physics to forward a set of the final page-proofs of each of their issues to one or both of the editors of *Science Abstracts* and the *Bulletin Analytique du Centre National de la Recherche Scientifique* (Paris). This action was at first limited to a few selected periodicals in each country, and the report lists the periodicals which are co-operating in this way in the United Kingdom, the United States, France, the Netherlands, Switzerland, Canada, Australia and Japan, and further periodicals published in France, Italy and India, with the editors of which negotiations are still proceeding. As a net result a delay of six to eight weeks in the appearance of the most important abstracts in these two periodicals has been eliminated.

Measures have also been taken to increase the number of non-periodical publications dealt with. Physical societies have now agreed that, when an advance note of a paper or meeting is published, the account will mention the later publication of the full paper. Non-periodical publications in France will be reviewed by the editor of *Bulletin Analytique*, who will forward to *Science Abstracts* documents he considers should be abstracted, and a reciprocal service for non-periodical publications of the United Kingdom will be undertaken by the editor of *Science Abstracts*. Action is now being taken to extend this work to northern countries and also to cover, where necessary, colloquia and symposia organized under the auspices of the International Union of Pure and Applied Chemistry, though the Board recommends that, whenever possible, papers presented at such meetings should be published in one of the regular periodicals of physics. It is also stated in the report

that the *Physikalische Berichte*, which is resuming publication, is to apply for membership of the Board and that Dr. L. H. Lampitt was attending the Strasbourg meeting as an observer on behalf of the International Union of Pure and Applied Chemistry. The lists of periodicals of physics published in the Spanish and Portuguese languages have recently been reviewed and inquiries made with the view of compiling similar lists for Japan and the northern countries of Finland, Norway, Sweden, Denmark and the Netherlands. It has also been arranged that the Italian periodical *Il Nuovo Cimento* will publish in 1953 an extra number, including ten to twelve articles reviewing the work of Russian schools in certain special branches of physics.

AUTOMATIC GRAIN COUNTER FOR ASSESSING QUANTITATIVELY HIGH-RESOLUTION AUTORADIOGRAPHS

By Dr. R. A. DUDLEY* and Dr. S. R. PELC

Medical Research Council Radiotherapeutic Research Unit, Hammersmith Hospital, London

AN instrument for automatically counting photographic silver grains has been developed to permit the use of high-resolution, low-exposure autoradiography as a quantitative method. It is expected that this extension of autoradiographic techniques to yield quantitative information will greatly increase the value of this method.

The particular autoradiograph technique for which the grain counter has been designed is that in which stripping film is employed[1]. In this method a spatial resolution of about 2 μ can be obtained, through the use of a thin (3–4 μ), fine grain (0·3 μ diameter) emulsion (Kodak, Ltd., *NT2a*), superimposed in intimate and permanent contact over the tissue section. Background is very low.

Of the various possible methods of assessing quantitatively the photographic 'image', automatic grain counting is the most suitable. Microdensitometry is not practical with this emulsion, because density is too low to permit useful measurement. For example, a grain concentration of 6 grains/100 μ^2, which in favourable cases may be two or three times background fog, corresponds to an optical density of only 0·002. In autoradiographs, densities as low as this would be hopelessly masked by variations in background density in other parts of the preparation, such as in the tissue section itself. Experience has shown that the use of larger grains, big enough to give a significant density, would limit the high spatial resolution which is the chief merit of the stripping-film technique. Visual counting of grains is far too laborious as a method of quantitative measurement, except for the most specialized problems. Visual counting of tracks caused by β-particles, a possibility with the more sensitive minimum-ionization emulsions, is even more laborious and subjective than grain counting. Automatic counting of β-tracks is at present too difficult to be considered. The method of choice, automatic counting of grains, has the great advantages of high sensitivity, speed and freedom from subjective error; its one serious disadvantage is the instrumental complexity.

* Fulbright Scholar.

The automatic grain counter which has been built is basically similar to the flying-spot microscope and particle counter designed by Roberts[2]; a detailed technical description will be published elsewhere. In brief, the operation of the instrument is as follows. A scanning spot of light is produced on a television projection tube, placed about 10 in. above the eyepiece of a microscope. This spot sweeps out an ordinary television raster (pattern of closely spaced parallel lines). The raster, projected down through the microscope (thus in the reverse direction from that used in conventional microscopy), is focused on the autoradiograph emulsion placed in the ordinary object plane of the microscope. Both scanning spot and complete raster are reduced in size by a factor equal to the reciprocal of the magnification of the microscope. With an objective having a numerical aperture of 1·3 N.A., the spot diameter can be as small as 0·3 μ, the size of the grains. On the autoradiograph, the full raster covers an area of 50 μ × 50 μ; by masking off part of the projection tube screen, it is possible to limit the scanning to any desired part of the square. Beneath the microscope condenser is a photomultiplier which continuously measures the amount of light passing through the autoradiograph. When the scanning spot crosses a silver grain, which causes 30–50 per cent absorption of the light, the brief interruption of the light beam is converted to an electrical pulse at the photomultiplier output. These pulses are then amplified, sorted according to height, and fed into a scaler. The sorting is performed by a single-channel differential-amplitude discriminator, which eliminates both those pulses which are too small (for example, noise) and those which are too large (for example, 100 per cent extinction of scanning spot during the backsweep of the spot) to be pulses caused by grains. The complete field of view is scanned once every 0·02 sec., but for greater accuracy the count is summed over about 175 successive scans in a period of 3·5 sec.

The automatic count is not absolute, although it can be calibrated by a visual count if desired. The larger grains are probably counted somewhat more frequently than the smaller ones; but this condition can be improved, if required, by careful adjustment of the discriminator levels.

Besides the counting circuits, provision is also made for a flying-spot microscope picture of the area being scanned. This is produced on a television display tube the spot of which traces out a raster synchronized with the projection-tube raster. The output from the photomultiplier controls the instantaneous brightness of the display spot, which therefore 'paints' on its screen a picture of the field of view. A useful visual check on the automatic counting process is provided by arranging that, at the instant a count is recorded by the scaler, a brightening pulse is fed on to the display tube. The picture then shows the silver grains in the field as black dots; those grains which are being counted are followed immediately by a bright dot.

One optical problem in the counting is that the emulsion is too thick for all the grains to be in focus at once. A method of surmounting this problem is to count at several planes of focus, each separated by a small, accurately reproducible distance from its neighbours. Simple depth of focus adjustment is possible by altering the mechanical tube-length of the microscope. If a 95 × objective is in use, lifting the eyepiece 1 mm. raises the plane of focus 0·1 μ.

Experience shows that this adjustment can be carried out, for a range of at least 4 μ depth of focus, without seriously affecting either microscope magnification or aberrations.

The fundamental instrumental difficulty in the grain counter has lain in reducing spurious counts to such a low number that they do not mask true grain counts. The most troublesome source of spurious counts is the inherent statistical fluctuations in the small number of light photons which examines each potential grain site in the emulsion. However, this problem has been satisfactorily solved by careful attention to the signal-to-noise ratio problems throughout the optics and electronics.

A set of preliminary grain-counting tests has been carried out with the instrument. While more experience must be acquired before the performance of the counter can be fully assessed, these first tests have proved that it will fulfil its purpose. Short-term stability is very good. Repeated counts on the same area of film have been made over various periods of time extending up to 1½ hr. In all cases, drifts amounted to less than 2–3 per cent. Sensitivity, in terms of minimum measurable grain concentration, is satisfactory. It was found that the minimum grain concentration ever encountered, namely, fog background of about 2 grains/100 μ^2 (equivalent to a density of 6×10^{-4}), could be reliably measured above the spurious counting-rate. Absorption of the scanning light by the tissue section, unstained or lightly stained, will introduce only second-order interference.

Emulsion sensitivity is sufficiently uniform to make it possible to compare counts on different areas of a single slide. In testing this, automatic grain counts were taken at 27 points over an area of 1 cm. × 3 cm. of a slide uniformly exposed to γ-rays, each count covering a square of 33 μ × 33 μ. The standard deviation of the individual counts was 6 per cent, of which at least a considerable part could be attributed to true statistical fluctuations in grain number.

The magnitude of the automatic grain count is very closely proportional to the exposure of the emulsion. An example is shown in Fig. 1, for which exposures were produced by thick sources of strontium-90 – yttrium-90 incorporated in plaster of paris. Development of the emulsion was carried out for 5 min. at 17·5° C. in *D* 19 *b*. With a counting time of 3½ sec., the automatically counted number of grains per 100 μ^2 is about 80 per cent of the number counted visually. The total height of the vertical line through each point in Fig. 1 is equal to twice the standard deviation in the number of grains counted at that point.

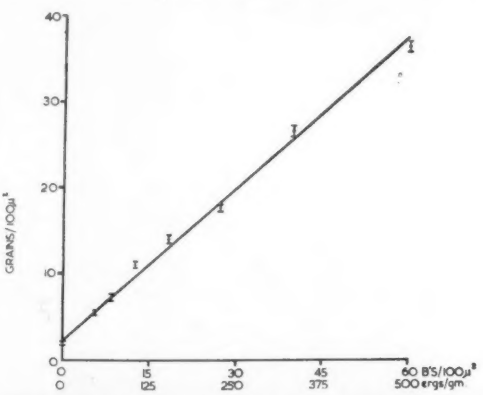


Fig. 1. Plot of automatic grain count vs. associated β-ray exposure on *NT2a* stripping film. Exposure is given in absolute units of both dosage and number of β-particles per unit area. Vertical lines through points represent standard deviation based on number of grains counted

We are indebted to Mr. F. Roberts for his generous help and advice, and to Messrs. J. Crawley and T. Davis for technical assistance. [Oct. 1.

[1] Doniach, I., and Pelc, S. R., *Brit. J. Rad.*, **23**, 184 (1950). Berriman, R. W., Herz, R. H. L., and Stevens, G. W. W., *Brit. J. Rad.*, **23**, 472 (1950).

[2] Young, J. Z., and Roberts, F., *Nature*, **167**, 231 (1951). Roberts, F., and Young, J. Z., *Proc. Inst. Elec. Eng.*, **99**, Part III A, No. 20, 747 (1952).

THE B-VITAMINS IN WHEAT: THE UNIQUE ALEURONE LAYER

By Dr. J. J. C. HINTON, F. G. PEERS and Dr. B. SHAW

Research Association of British Flour Millers, Cereals Research Station, St. Albans

THE content of certain nutrients in a flour is determined by the distribution of these factors in the wheat grain and the milling technique used in producing the flour. It is thus important to have precise information as to the distribution of these nutrients in the grain.

The first attempt to separate the various anatomical fractions of the wheat grain for analysis was made by Girard[1], who obtained nitrogen figures for the embryo, endosperm and outer layers. More recently, information has been derived by the examination of the various milling streams, for example, the work of Andrews, Boyd and Terry[2] on riboflavin, Thomas, Bina and Brown[3] on nicotinic acid and Teply, Strong and Elvehjem[4] on nicotinic acid, pantothenic acid and pyridoxin. Such results, however, are not so informative as those obtained by analysis of the anatomical fractions of the dissected wheat grain.

Hinton[5,6] has developed microdissection techniques for the study of the distribution of nitrogen, aneurin and nicotinic acid in wheat var. Thatcher. The present communication extends this work to riboflavin and pantothenic acid. In addition, from assays of folic acid, biotin and pyridoxin in various flours, it is at least possible to suggest the probable distribution of these factors.

The dissections were carried out manually under a low-powered microscope, and the methods used have been fully described elsewhere[5]. The grain was divided into the principal anatomical regions, namely, pericarp + testa, aleurone, embryo, scutellum and endosperm. The factors were assayed by the microbiological techniques described by Barton-Wright[7], with the exceptions of folic acid and aneurin, which were determined by the methods of Jones and Morris[8] and Ridyard[9] respectively. With riboflavin and pantothenic acid, when only small amounts of certain fractions were available for assay, the method of extracting the factor was modified as described for nicotinic acid by Heathcote *et al.*[6].

Riboflavin. The results obtained are presented in Table 1 and are expressed on an air-dry weight basis equivalent to 87 ± 1 per cent dry matter. The figures in the table refer to the material dis-

Table 1. Distribution of Riboflavin in *Triticum vulgare* var. Thatcher

	Proportion of grain by wt. (per cent)	Riboflavin in fraction (μgm./gm.)	Riboflavin in grain (μgm./100 gm.)	Proportion of that in whole grain (per cent)
Whole grain	100	1·8	180	—
Pericarp + testa	8·2	—	—	—
Aleurone	6·7	10·0	67	37
Embryo	1·6	13·8	22	12
Scutellum	2·0	12·7	25	14
Endosperm	81·5	0·7	57	32
	100·0		171	95

Table 2. Distribution of Pantothenic Acid in *Triticum vulgare* var. Thatcher

	Proportion of grain by wt. (per cent)	Pantothenic acid in fraction (μgm./gm.)	Pantothenic acid in grain (μgm./100 gm.)	Proportion of that in whole grain (per cent)
Whole grain	100	7·8	780	—
Pericarp + testa	8·2	7·8	64	8
Aleurone	6·7	45·1	302	39
Embryo	1·6	17·1	27	3·5
Scutellum	2·0	14·1	28	4
Endosperm	81·5	3·9	318	41
	100·0		739	95·5

sected from a number of grains and not to the fractions of an individual grain. The pericarp + testa fraction contained very little riboflavin (less than 5 per cent), and accordingly no attempt was made to obtain the exact figure because of the tedium in dissecting the large amount required. The other figures are the means of duplicate determinations, and there is good agreement between the riboflavin content of the whole grain and the total of that in the various fractions.

Pantothenic acid. The results, again expressed on an air-dry weight basis and the means of duplicate assays, are given in Table 2. With this vitamin it was possible to obtain a figure for the pericarp + testa fraction on a relatively small amount.

In Table 3 the results obtained previously for aneurin[5] and nicotinic acid[6] have been summarized, together with the results reported above for riboflavin and pantothenic acid. The table shows clearly the differences in the pattern of the distribution of these four vitamins. Common to them all, however, is the relatively high concentration of each in the aleurone layer, nicotinic acid being, of course, outstanding: in fact, we believe the aleurone layer of cereals to be the richest natural source of this vitamin.

In wheat, the aleurone layer is derived from the endosperm tissue, which is generally accepted to result from the fusion of the polar nuclei with the second male gamete, the first gamete fertilizing the ovum to produce the embryo. This aleurone layer, which constitutes less than 7 per cent of the total weight of the grain, contains 31 per cent of the aneurin, 84 per cent of the nicotinic acid, 37 per cent of the riboflavin and 39 per cent of the pantothenic acid.

Other B-vitamins. Accurate information on the distribution of the remaining B-vitamins is not yet available. Table 4, however, shows the vitamin content of certain flours with respect to pyridoxin, folic acid, biotin and the four factors already discussed. These figures suggest that pyridoxin and folic acid are distributed in a similar manner to riboflavin, whereas the distribution of biotin may resemble either that of nicotinic acid or that of pantothenic acid. Furthermore, from the figures quoted by Pringle and Moran[10] for the phytin content of various milling fractions, it would appear that about 80 per cent of the total phytin is found in the bran, which is composed of the pericarp, testa and aleurone layers together with small amounts of endosperm. Hence, since most of the inositol (another member of the B-group of vitamins) in wheat is present in this form, that is, a mixed calcium and magnesium salt of inositol hexaphosphoric acid, it is probable that a high concentration of this vitamin also exists in the aleurone layer. Thus the conclusion is that all those members of the B-vitamin group upon which we have any data are present in high concentration in this layer.

Discussion. The various members of the B-vitamin complex are all thought to be coenzymes or to be involved in some way in specialized enzyme systems. Thus, aneurin is known to be involved in several enzymatic reactions connected with carbohydrate metabolism, the best known of which is probably the carboxylase reaction; riboflavin and nicotinic acid are known to enter into several mechanisms concerned with the transfer of hydrogen and thus respiration; pantothenic acid is concerned in acetylation reactions, while pyridoxin derivatives

Table 3. Distribution of Certain B-Vitamins in the Wheat Grain

Fraction	Total in fraction as percentage of that in whole grain: Aneurin	Nicotinic acid	Riboflavin	Pantothenic acid	Concentration in each fraction in μgm./gm.: Aneurin	Nicotinic acid	Riboflavin	Pantothenic acid
Pericarp + testa	1	4	~5	8	0·6	25·7	~1·0	7·8
Aleurone	31	84	37	39	16·5	741	10·0	45·1
Embryo	2	1	12	3·5	8·4	38·5	13·8	17·1
Scutellum	62·5	1	14	4	156	38·2	12·7	14·1
Endosperm	3	11·5	32	41	0·13	8·5	0·7	3·9

Table 4. The B-Vitamin Content of Flour
(All figures are expressed as μgm./gm. flour at 13 ± 1 per cent moisture)

Flour	Aneurin	Nicotinic acid	Riboflavin	Folic acid	Biotin	Pyridoxin	Pantothenic acid
1. Patent	0·54	8·7	0·55	0·10	0·011	3·3	1·0
2. White flour (77·4 per cent extraction)	1·79	14·9	0·70	0·13	0·020	3·8	1·9
3. National flour (80 per cent extraction)	2·31	17·0	0·69	0·13	0·025	4·0	2·3
4. 'Low-grade' flour rich in germ and bran	3·36	22·7	0·90	0·17	0·031	4·4	2·9
5. Wholemeal flour or whole grain	3·75	59·3	1·70	0·37	0·090	9·3	7·4

enter into several enzymic reactions concerned with amino-acid metabolism.

Although distribution studies have not been carried out upon the enzymatic reactions involving these co-factors, Engel and his co-workers[11] have studied the distribution of a number of enzymes in wheat, using techniques based upon serial sectioning of the grain. Their results show that amylase is found principally in the outer endosperm and scutellum but not in the aleurone layer or embryo; proteinase is found mainly in the aleurone layer and not in the endosperm, small amounts being found in the embryo and scutellum; dipeptidase and esterase activities are high in the scutellum, embryo and aleurone layer and low in the endosperm. A study of phytase[12], based upon the dissection techniques used in this communication, has also shown that the aleurone layer and the scutellum have the highest activities. Hence, with the enzymes so far studied, with the exception of amylase, their activity is high, if not greatest, in the aleurone layer. Another point of interest in connexion with the aleurone layer is that the ash content and thus the mineral content is higher than that of any other fraction of the wheat grain (unpublished observations by Hinton).

In seeds, the potential centre of metabolic activity is the embryo, and the high concentration of aneurin in the scutellum, which is a specialized part of the embryo, could be explained on this basis. It is another matter, however, to find the concentration of essential metabolites mentioned above in the aleurone layer, which is a tissue unrelated to the embryo. On the other hand, it is customary to regard the carbohydrate and protein found outside the embryo of a resting seed as deposits to be mobilized as required by the developing seedling. It might

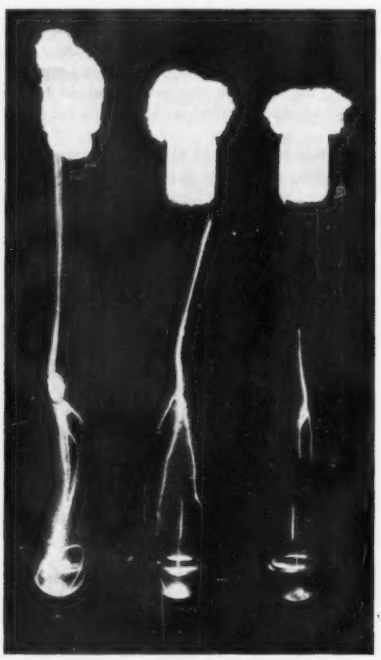


Fig. 1. Wheat plants in test-tube culture seven days after germination. Left, from whole seed; centre, from embryo plus scutellum; right, from embryo alone

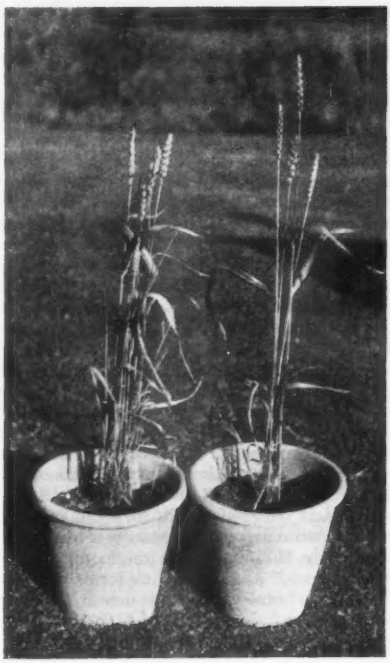


Fig. 2. Mature wheat plants (var. Atle) from excised embryos grown in 10-in. pots. Left, from embryo alone; right, from embryo with scutellum. The grain was under-weight, but normal and viable

therefore be suggested that these 'deposits' of vitamins and enzymes in the aleurone layer could have the same role. Against this, however, it is known that excised cereal embryos will develop to maturity on a nutrient medium which does not contain any added source of vitamins or growth factors[6,13]. Though the growth of the plant is somewhat weak, development can proceed normally to maturity, as is shown in the accompanying photographs.

The significance, therefore, of the high content of the B-vitamins and of minerals and the high enzymic activities in the aleurone layer still awaits explanation. Certainly they do not appear to play a decisive part in the metabolic processes of the developing embryo.

We are indebted to Mr. H. N. Ridyard for the aneurin estimations in Table 4. [Oct. 13.

[1] Girard, A., in Lindet, L., "Le Froment et sa Mouture" (Gauthier-Villars, Paris, 1903).
[2] Andrews, J. S., Boyd, H. M., and Terry, D. E., *Indust. Eng. Chem. (Anal. Edit.)*, **14**, 271 (1942).
[3] Thomas, J. M., Bina, A. F., and Brown, E. B., *Cereal Chem.*, **19**, 173 (1942).
[4] Teply, L. J., Strong, E. M., and Elvehjem, C. A., *J. Nutr.*, **24**, 167 (1942).
[5] Hinton, J. J. C., *Proc. Roy. Soc.*, B, **134**, 418 (1947).
[6] Heathcote, J. G., Hinton, J. J. C., and Shaw, B., *Proc. Roy. Soc.*, B, **139**, 276 (1952).
[7] Barton-Wright, E. C., *Analyst*, **70**, 283 (1945).
[8] Jones, A., and Morris, S., *Analyst*, **74**, 29 (1949).
[9] Ridyard, H. N., *Analyst*, **74**, 18 (1949).
[10] Pringle, W. J. S., and Moran, T., *J. Soc. Chem. Indust.*, **61**, 108 (1942).
[11] Engel, C., *Rec. Trav. chim. Pays-Bas*, **64**, 318 (1945); *Biochim. Biophys. Acta*, **1**, 42, 278 (1947). Engel, C., and Heins, J., *Biochim. Biophys. Acta*, **1**, 190 (1947). Engel, C., and Bretschneider, L. H., *Biochim. Biophys. Acta*, **1**, 357 (1947).
[12] Peers, F. G., *Biochem. J.*, **53**, 102 (1953).
[13] Purvis, O. N., *Ann. Bot. Lond.*, **30**, 285 (1944).

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Fine Structure of the Extra-terrestrial Radio Source Cygnus I

The investigation of the nature of the intense localized sources of extra-terrestrial radio emission which were discovered in 1948 has been hampered by the technical difficulties of achieving sufficient resolution to measure their dimensions. Partial solutions of these difficulties were reached simultaneously in 1952 by independent developments at Cambridge, Jodrell Bank and Sydney[1–3], as a result of which preliminary measurements of the angular diameters of the intense sources in Cassiopeia and Cygnus were made. These measurements were not in complete agreement, particularly in the case of the Cygnus source, where the Jodrell Bank results indicated that the source might be markedly asymmetrical. During the past year the fine structure of this source has been studied in greater detail, and the present communication summarizes the results obtained.

The investigation has been made on a frequency of 125 Mc./s. with an interferometer which has been described elsewhere[1,4,5]. It measures the variation of the correlation function ρ^2 with the aerial separation in terms of wave-lengths (N), where

$$\rho^2 = \frac{F^2 \cos \psi + F^2 \sin \psi}{F^2 \cos (o)}$$

and $F \sin \psi$ and $F \cos \psi$ are the sine and cosine terms of the Fourier transform of the angular distribution of intensity across the source[4]. The original measurements made by Hanbury Brown, Jennison and Das Gupta[1] with this interferometer were carried out at position angles of 58°, 113°, 179°, and the results indicated that the source was radially asymmetrical with a major axis near position angle 90°. In order to obtain a self-consistent set of results with these earlier measurements in a direction close to the major axis, the present investigation has been made at a number of spacings in the position angle 113°. The correlation function and the corresponding values of N are given in the accompanying table.

The measurements of Smith[2] and Mills[3] were made in position angle 90°, and in order to compare the three sets of results the present observations have been transformed into a position angle of 90°. This has been done by projecting the values of N from position angle 113° to 90°, and the values are given in the table.

The intensity distribution shown in Fig. 1 compares these results with those of Smith and Mills. The magnitude of the secondary maximum indicates that

Interferometer Spacings N and Corresponding Correlation Coefficient ρ^2 from the Extra-terrestrial Radio Source Cygnus 1

N at 113°	N projected into 90°	$\rho^2 \pm 0{\cdot}04$
610	560	0·460
650	598	0·500
900	830	0·200
1,450	1,340	0·045
1,558	1,440	0·065
1,655	1,520	0·120
1,952	1,800	0·245
2,100	1,930	0·280
2,230	2,050	0·290

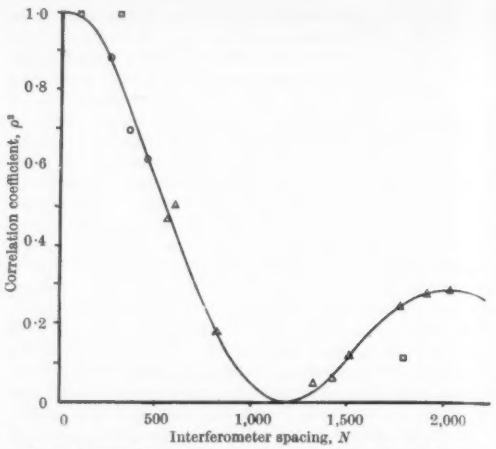


Fig. 1. Correlation coefficients ρ^2 measured at various interferometer spacings, N, for the radio source in Cygnus. Observations by Smith, ○; observations by Mills, □; observations by Jennison and Das Gupta, △. The continuous curve denotes the theoretical transform of the distribution shown in Fig. 2

the source must have at least two distinct centres of emission. The distribution of intensity across the source cannot be determined uniquely since the phase of the transform is unknown; however, the shape of the curve in Fig. 1 suggests that the phase of the transform is reversed in the secondary maximum, and this favours a symmetrical source with two centres of emission.

The simplest distribution which will yield the transform shown in Fig. 1 consists of two components of equal intensity, each of length 51″, separated by 1′ 28″. The additional information[1] supplied by the results obtained on bearings of 179° and 58° indicates that the source has a very small minor axis—less than 35″ in a position angle of approximately 180°—and it is apparent that the components forming the source must be distributed in a narrow strip as shown in Fig. 2.

The accurate position of the radio source in Cygnus has been determined by Smith[6]. It coincides with an extra-galactic object photographed at the 200-in. Hale telescope by Baade and Minkowski[7]. This object has a maximum diameter of 30″ in position angle 150° and shows a high excitation emission spectrum with marked signs of tidal distortion. It has been interpreted by Baade and Minkowski as two late-type spiral galaxies in collision. Although Fig. 2 represents the most compact distribution of

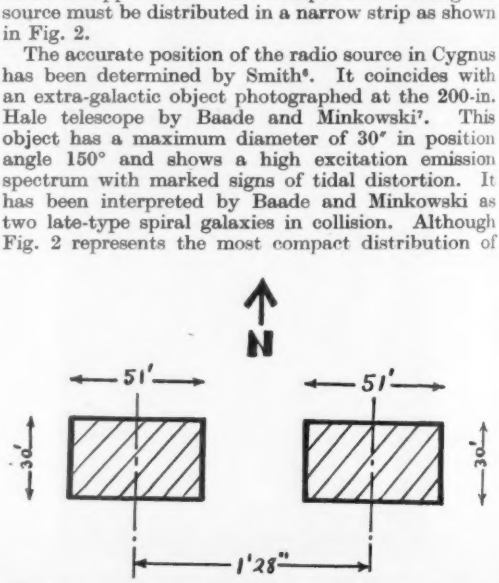


Fig. 2. Approximate intensity distribution of the extra-terrestrial radio source in Cygnus

the radio source which can be derived from the measurements shown in Fig. 1, it is nevertheless much larger than the visual object described above. The two components of the radio source straddle the visual object with little overlap between the regions of optical and radio emission. If this identification of the radio source is correct, there would appear to be no direct correlation between the radio emission and the visible light from the colliding galaxies.

The work was made possible by a grant from the Department of Scientific and Industrial Research. We wish to thank Prof. A. C. B. Lovell and Mr. R. Hanbury Brown for their interest in the investigation. We are also indebted to Drs. Baade and Minkowski for the information about their work on the colliding galaxies in advance of publication. One of us (M. K. D. G.) is indebted to the Government of India for a scholarship and to the Department of Scientific and Industrial Research for a maintenance grant, and the other (R. C. J.) to the Royal Society for the Mackinnon studentship.

R. C. Jennison
M. K. Das Gupta

Jodrell Bank Experimental Station,
Lower Withington,
Cheshire.
Nov. 4.

[1] Hanbury Brown, R., Jennison, R. C., and Das Gupta, M. K., *Nature*, **170**, 1061 (1952).
[2] Smith, F. G., *Nature*, **170**, 1065 (1952).
[3] Mills, B. Y., *Nature*, **170**, 1063 (1952).
[4] Hanbury Brown, R., and Twiss, R. Q. (in publication).
[5] Jennison, R. C., and Das Gupta, M. K. (in publication).
[6] Smith, F. G., *Nature*, **168**, 555 (1951).
[7] Baade, W., and Minkowski, R. (in publication).

An Extended Radio-frequency Source of Extra-galactic Origin

The detection of the radio-frequency radiation from the Galaxy[1] together with that from a number of individual nebulæ[2–5] (types *Sb* or *Sc*) suggests that the emission of radio energy is a common property of the spiral nebulæ. It is therefore to be expected that the marked irregularities which are observed in the distribution of extra-galactic nebulæ (see Fig. 1) will give rise to corresponding irregularities in the radio isophotes of the sky. In a previous publication[3] we reported the detection at 158·5 Mc./s. of an extended band of low-intensity radiation, lying between declinations N. 44° and N. 54° and centred at R.A. 12h., and we suggested that the irregularity is associated with a concentration of nebulæ.

Since the publication of these preliminary results, the observations of the band have been extended to cover the declination range N. 40° to N. 70°, which represents the limit of the field of view of the aerial system (the 218-ft. paraboloid of the Jodrell Bank Experimental Station). The boundaries of the band observed over this region are given by the heavy lines in Fig. 1, and a comparison with the distribution of bright nebulæ indicates that the band is associated with the dense strip of nebulæ which extends over a wide range of declination and lies between R.A. 11h. and R.A. 13h. This identification has recently received support from some observations of Kraus and Ko[6], who have measured the radiation at 250 Mc./s. from that part of the band of nebulæ which lies between N. 15° and S. 15°. The broken lines in Fig. 1 show the loci of maximum intensity in the band of radiation which they reported. They noted that the band is about 15° wide and is bifurcated above the celestial equator.

The intensity of the band observed at 158·5 Mc./s. is about 3×10^{-26} W./sq. m./c.p.s./sq. degree, while the intensity of the band at 250 Mc./s. is given as 1×10^{-25} W./sq. m./c.p.s./sq. degree at a declination of S. 5°. The spectrum of the radiation from the band has been estimated from some observations made at 72 Mc./s. and 158·5 Mc./s. with the 218-ft. paraboloid, and the intensity appears to vary inversely as the square root of the frequency. Assuming this spectrum, the intensity observed at S. 5° corresponds to an intensity at 158·5 Mc./s. of $1{\cdot}5 \times 10^{-25}$ W./sq. m./c.p.s./sq. degree, which is greater by a factor of 5 than that observed between declinations N. 40° to N. 70°. This increase of intensity towards the Virgo region is to be expected from the distribution of the bright nebulæ, and the factor of 5 is in reasonable agreement with the plot of nebular density given by de Vaucouleurs[7].

A comparison has been made of the observed radio intensity with that to be expected if all nebulæ show the same ratio of radio flux to light flux as that found for individual spirals[5]. The analysis is based on a detailed survey made by Shapley and Jones[8], which gives the counts of nebulæ on a series of photographic plates taken in a strip 5 degrees wide and centred on declination N. 43°. When estimating the total light flux from the nebulæ in this strip, it was assumed that they obey Holmberg's luminosity function, and a correction was applied to the counts for nebulæ below the plate limits. An additional small correction was applied to the integrated light flux to allow for the absorption of visual radiation by interstellar matter in nebulæ viewed edge-on. It was found that the observed radio flux is more intense

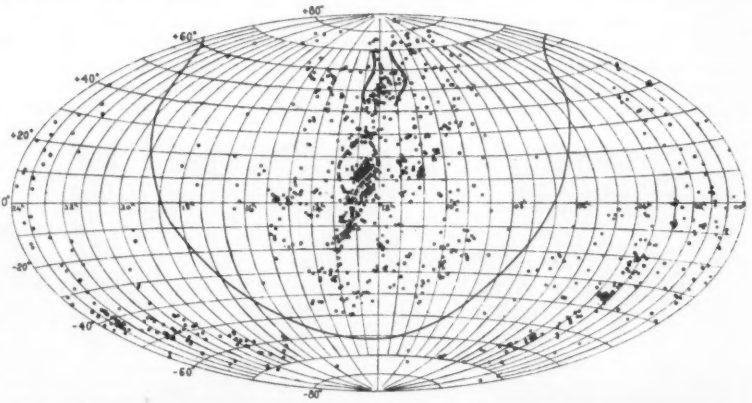


Fig. 1. Distribution of extra-galactic nebulæ brighter than the 13th photographic magnitude as given by Shapley and Ames. The heavy full lines show the boundaries of the band of radio-frequency radiation observed at 158·5 Mc. s. The broken line represents the loci of the points of maximum intensity of the band observed by Kraus and Ko at 250 Mc./s.

by about 1·7 magnitudes than that calculated. Part of this discrepancy may be caused by failure of the photographic observations to measure the light from the outer regions of the faint nebulæ, but it seems unlikely that the correction for this effect can reduce the discrepancy to less than 1 magnitude. This result may indicate that the ratio of radio to light flux for late-type spirals does not hold for all types of nebulæ.

The work has been carried out at the Jodrell Bank Experimental Station of the University of Manchester. We wish to thank Prof. A. C. B. Lovell for his interest in the investigation. One of us (R. H. B.) is indebted to Imperial Chemical Industries, Ltd., for a research fellowship.

R. Hanbury Brown
C. Hazard
Jodrell Bank Experimental Station,
Lower Withington,
Cheshire.
Oct. 8.

[1] Jansky, K. G., *Proc. Inst. Rad. Eng.*, **20**, 1920 (1932).
[2] Hanbury Brown, R., and Hazard, C., *Mon. Not. Roy. Astro. Soc.*, **111**, 357 (1951).
[3] Hanbury Brown, R., and Hazard, C., *Phil. Mag.*, **43**, 137 (1952).
[4] Hanbury Brown, R., and Hazard, C., *Mon. Not. Roy. Astro. Soc.*, **113**, 123 (1953).
[5] Hanbury Brown, R., and Hazard, C., *Nature* [**172**, 853 (1953)].
[6] Kraus, J. D., and Ko, H. C., *Nature*, **172**, 538 (1953).
[7] de Vaucouleurs, G., *Astro. J.*, **58**, 30 (1953).
[8] Shapley, H., and Jones, R. B., *Proc. U.S. Nat. Acad. Sci.*, **26**, No. 9 554 (1940).

Thermal Decomposition of Dolomite

In 1951, Wilsdorf and Haul[1] estimated from X-ray powder diagrams the size of the magnesium oxide crystallites formed when dolomite is heated to 600°–640° C. to be 10^{-5} to 10^{-4} cm. in diameter, and presumed that the crystallites were located on the periphery of the recrystallized calcite. In this work a pure dolomite crystal from Binnental, Switzerland, was used.

During the course of a joint study of dolomites, two showing distinct differences in their thermograms —from Steetley, Co. Durham, and from Loch Kishorn, Ross and Cromarty (Fig. 1)—were selected for further investigation, and powdered samples of these were heated in the differential thermal analysis apparatus[2] to the temperature corresponding to the junction between the two peaks. X-ray examination at this point revealed the presence of only magnesium oxide and calcium carbonate.

Electron micrographs made by one of us (R. M.) at the Rheinisch-Westphälisches Institut für Übermikroskopie show large crystals covered with small crystallites. In the pictures of Steetley dolomite (Fig. 2), the commonest sizes of the crystallites are 1–4 × 10^{-5} cm. in diameter; but the total range is 1–6 × 10^{-5} cm. agreeing closely with X-ray evidence on a different material. That the crystallites in the Loch Kishorn dolomite appear to be smaller (mainly 1 and 2 × 10^{-5} cm. in diameter) is perhaps not surprising as the difference in rate of decomposition of the two samples (Fig. 1) would suggest that the magnesium oxide crystals from Steetley would have relatively more time to grow. In both preparations a small proportion of the crystallite material is seen apart from the larger crystals.

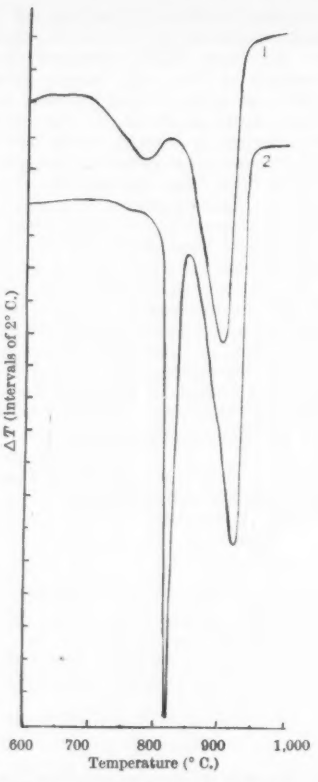


Fig. 1. Differential thermagram of (1) Streatley dolomite, (2) Loch Kishorn dolomite

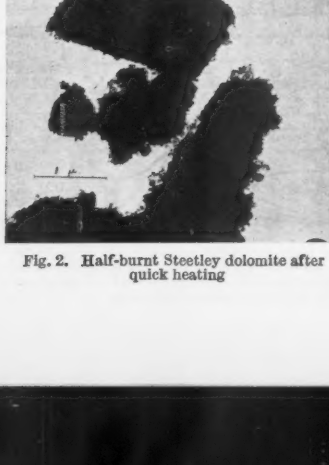


Fig. 2. Half-burnt Steetley dolomite after quick heating

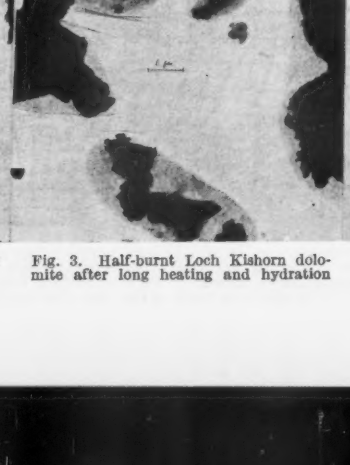


Fig. 3. Half-burnt Loch Kishorn dolomite after long heating and hydration

Fig. 4. Half-burnt Loch Kishorn dolomite after long heating and treatment with ammonia solution

When the dolomites were heated to 1,000° C., X-ray examination showed them to consist only of magnesium oxide and calcium oxide; the crystallites of magnesium oxide have now grown to about twice the size, and rather larger quantities have parted from the mother crystals, which are now pseudomorphs after calcite. One can also see that the crystallites nearest the decomposed calcite are often spherical or botryoidal in shape and that those farther away are usually unevenly grown octahedra.

Great care was taken to keep these samples dry; but one set of samples, after heating to 800° C. for a short time and then at 750° C. for 2 hr., was allowed to pick up atmospheric moisture (Fig. 3). In this case the magnesium oxide crystallites had been almost entirely replaced by an envelope of magnesium hydroxide enclosing the calcite crystals. In some of the clearest pictures, these hulls are seen to consist of an open network of minute needles.

When the half-burnt preparations from the last experiment were dispersed in a large volume of $N/100$ ammonium hydroxide solution (probably containing ammonium carbonate) the magnesium hydroxide crystallites dissolved and the remaining calcite (Fig. 4) is seen to have a perfect rhombic habit. Although the photograph shows a large single crystal about 3×10^{-3} cm. in length (with a little magnesium hydroxide still adhering), the calcite occurs mainly as aggregates of rhombs, about $0{\cdot}5$–1×10^{-3} cm. in length. Half-burnt dolomites from the differential thermal analysis apparatus, on the other hand, had been in the temperature-range 700°–800° C. for only 10 min., and in this time the calcite crystals, extracted with the ammonium hydroxide solution, are much less perfectly crystallized.

Electron micrographs of finely ground dolomite showed no perfect rhombs and few good cleavage planes. The present work confirms, therefore, that calcite crystallizes as the magnesium oxide leaves the dolomite lattice and becomes more perfect in crystal habit on continued heating.

We acknowledge the interest shown and help given by Dr. R. C. Mackenzie and Mr. W. A. Mitchell, of the Department of Pedology, Macaulay Institute for Soil Research, Aberdeen.

ROBERT MELDAU

Harsewinkel,
Westphalia,
Germany.

ROBERT H. S. ROBERTSON

16 Kirklee Road,
Glasgow, W.2.
Aug. 10.

[1] Wilsdorf, H. G. F., and Haul, R. A. W., *Nature*, **167**, 945 (1951).
[2] Mackenzie, R. C., *Anal. Edafol. Fisiol. veg.*, **11**, 159 (1952).

Creep Curve for a Precipitation-hardened Alloy

IN recent years, there has been much interest[1–5] in the nature of creep curves obtained when metals are deformed at constant stress and temperature. Most of the experiments in this field refer to pure metals, but there has been some theoretical and experimental work[6,7] on the interesting subject of a precipitation-hardened alloy.

Some experiments have been performed here on creep deformation in a polycrystalline precipitation-hardened alloy, which show novel features depending mainly on the temperature of deformation. A binary alloy was used of composition 97 per cent copper–3 per cent silver, which was heat-treated to give a Widmanstätten structure of maximum hardness and stability. Wires of this alloy were subjected to small axial creep strains at constant stresses and temperatures.

Two distinct transient creep mechanisms and a quasi-viscous creep mechanism were observed. The first transient creep mechanism occurs at the lower temperatures (100° C. and 150° C.) according to the equation:

$$\varepsilon = \alpha \ln t,$$

where ε is the creep strain at time t. This equation is typical of the exhaustion theory of transient creep[5,6] and is accounted for by a discussion put forward by Smith[3]. At higher temperatures (200° C. and 250° C.), the second transient creep term which obeys Andrade's law[1] is dominant over the first, and an additional quasi-viscous term is present:

$$\varepsilon = \alpha \ln t + \beta t^{1/3} + \gamma t.$$

A similar relationship in regard to α- and β-transient creep has been found in pure metals by Wyatt[4].

At the highest temperatures used (275° C. and 300° C.), α-creep is negligible and the γ term is valid only up to a critical time (t_0) beyond which it is reduced exponentially with time:

$$t < t_0 \quad \varepsilon = \beta t^{1/3} + \gamma t$$

$$t > t_0 \quad \varepsilon = \beta t^{1/3} + \gamma t_0 + \alpha\gamma \{1 - \exp -(t - t_0)/a\}.$$

The critical time effect is believed to be due to the comparatively large instantaneous plastic strain (P) on initial stressing, giving rise to a disordered structure at crystal boundaries, and allowing a limited boundary creep strain (γt_0) before further strain hardening. This view is supported by the constancy of the ratio $\gamma t_0/P$. It is hoped to publish full details of this work elsewhere.

I am indebted to Mr. J. V. Hardwick for discussions on the above work and to Mr. L. J. Davies, director of research, The British Thomson-Houston Co., Ltd., for permission to publish this communication.

G. C. E. OLDS

Research Laboratory,
The British Thomson-Houston Co., Ltd.,
Rugby.
Aug. 13.

[1] Andrade, E. N. da C., *J. Iron and Steel Inst.*, **171**, 217 (1952).
[2] Cottrell, A. H., and Aytekin, V., *J. Inst. Metals*, **77**, 389 (1950).
[3] Smith, C. L., *Proc. Phys. Soc.*, **61**, 201 (1948).
[4] Wyatt, O. H., *Proc. Phys. Soc.*, B, **66**, 459 (1953).
[5] Cottrell, A. H., *J. Mech. Phys. Solids*, **1**, 53 (1952).
[6] Mott, N. F., and Nabarro, F. R. N., Conf. on Strength of Solids, 1948 (Phys. Soc., London).
[7] Davis, M., and Thompson, N., *Proc. Phys. Soc.*, B, **63**, 847 (1950).

Structure of Ion-exchanged Forms of Chabazite

THE structure proposed by Wyart[1] for chabazite includes only the case for the divalent calcium ions, in the positions $\pm$ (0·17, 0·17, 0·17). In the case of a chabazite containing monovalent ions, these must also be placed on the triad axis if the symmetry D_{3d}^5 is to be maintained without the formation of a 'defect structure'. Barrer[2] has shown that ion-exchanged forms of chabazite rich in the alkali metal cations, among others, give X-ray powder photographs showing negligible alterations in spacings when compared

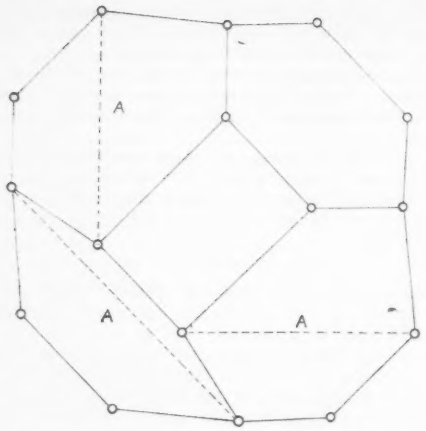


Fig. 1. Projection of the four six-membered rings of aluminiums and silicons in the upper half of the unit cell of chabazite

with the parent mineral. This indicates that the alumino-silicate network is essentially the same for all the cations, from lithium to cæsium. Initially, it would appear suitable to place these ions at the points (0, 0, 0), (0·5, 0·5, 0·5) and ± (0·25, 0·25, 0·25). However, these four positions are not all equivalent to one another, and, further, the situation of a cation at (0·5, 0·5, 0·5), for example, where it is in the centre of a cage which is otherwise devoid of atoms, is unlikely.

A further alternative, also mentioned by Wyart as a possibility for the calcium form, is that the ions occupy the positions (0·25, 0·25, 0·75), giving, as he states, six equivalent positions. This would result in a 'defect structure', similar to that of analcite as originally proposed by Taylor[3], with either two divalent or four monovalent ions in a statistical distribution between six of the lattice points.

Fig. 1 is a projection of the four six-membered silicon and aluminium rings found in the upper half of the unit cell of chabazite. The centres of three of these approximately planar rings represent half the six crystallographically equivalent positions (0·25, 0·25, 0·75) denoted by *A*. The dotted line in each of the *A* rings indicates the position of the widest portion of the hexagon formed (7·4 A.), the other distances being smaller and equal (6·2 A.). Each silicon or aluminium takes part in four rings of the type shown, so that on the average each contains four silicons and two aluminiums. A little consideration will show that it is impossible to place silicons and aluminiums in these rings so that the positions *A* are equivalent while the ratio of silicon to aluminium remains at two to one. Therefore, it follows that two only of these positions can be energetically equivalent, due to the presence of both aluminium and silicon atoms, although all three are crystallographically equivalent.

From the above discussion, it is apparent that the four monovalent ions in the unit cell of chabazite may be in four of the six positions given by (0·25, 0·25, 0·75) without the resultant lattice necessarily having the characteristics of a 'defect structure'. There is not room to accommodate the larger cations exactly in these sites, with the result that some slight displacement of these ions to fresh equilibrium positions will occur.

It is possible to apply similar reasoning to the case of a chabazite containing only divalent ions, since a position of minimum potential energy for a monovalent ion is not necessarily representative of the potential energy-well for a divalent ion. In complex structures of this type, it is probable that cation–cation coulombic repulsion forces are of great importance in determining the equilibrium position. Incidentally, it would appear that there is an error in "Strukturbericht"[4], where the positions of the silicon–aluminium atoms in chabazite are shown with $Z_{Si} = -0{\cdot}14$. This should read $Z_{Si} = -0{\cdot}01$.

I. R. Beattie

Chemistry Department,
University,
Sheffield 10. July 27.

[1] Wyart, J., *Bull. Soc. Franc. Min.*, **56**, 81 (1933).
[2] Barrer, R. M., *J. Chem. Soc.*, 2342 (1950).
[3] Taylor, W. H., *Z. Krist.*, **74**, 1 (1930).
[4] "Strukturbericht", **3–4**, 151 (1933–36).

Small-Angle X-Ray Scattering and Interparticle Interference in Rayons

The scattering of X-rays at small angles by fibres furnishes important information about their microcrystalline structure. In a systematic study of this type of X-ray scattering by fibres[1], it was found that in the swollen condition these materials exhibit a more intense scattering over a much wider angle than in the dry state; this has been confirmed by others[2,3]. The effect was explained by the denser packing of the scattering particles (microcrystallites) in the dry state, and the greater extent of interference of the scattered radiation from neighbouring particles to be expected in this condition, as compared to the swollen condition where the particles scatter more independently.

An investigation of the scattering by fibres in stages between the dry and highly swollen condition proved of interest for obtaining a deeper insight into the phenomenon of interparticle interference in these materials and with regard to the experimental conditions ensuring a reliable determination of microcrystallite size in fibres.

The material reported on in this preliminary note are two rayons of high orientation: 'Fortisan' (courtesy of the Celanese Corporation of America) and 'Fiber *G*' (courtesy of the du Pont de Nemours Company). Highly monochromatized K_α radiation and a beam of high quality obtained with two combined quartz crystals was used for the investigation. The distance between sample and film was 20 cm.

Fig. 1, *A* and *B* are full-size reproductions showing the scattering by these fibres, *A* in the dry condition, *B* in the water-swollen condition, *C* swollen beyond the water-swollen condition. The exposure in *A*, *B* and *C* is the same and the same fibre sample was used in each case. The proportions of average diameter of fibres in *A*, *B* and *C* are about 3½–4½ to 5–5½ to 6. The swelling beyond the water-swollen state is still of a purely intermicellar nature. The exact distribution of intensity is given by the curves of Fig. 2.

From the patterns and curves it is seen that the scattering of the fibre in the dry condition, *A*, is limited to a narrow angular distance from the centre, whereas the swollen fibres, *B* and *C*, show a wider distribution of intensity. In the water-swollen condition, *B*, the intensity passes through a maximum

and minimum. This has also been observed but not explained by others[3]. Maxima or inflexion points are found in almost any condition between the most compact (driest) and fully swollen states; some examples are given by the curves *B*, *B'* in Fig. 2. If the fibre is swollen beyond the water-swollen condition as represented by *C*, a distinct maximum is no longer observed. A slight inflexion is still seen in the curve *C* for 'Fortisan'; but even this is no longer present in curve *D* in Fig. 2 (for 'Fiber *G*'). The overall intensity in cases *C* and *D* is very much higher than in any of the other cases notwithstanding the higher absorption of X-rays by the highly swollen material.

The above finding that the extent and shape of the inflexion in the scattering curves varies with the degree of swelling can be fully explained on the basis of interparticle interference in the denser states of packing. The presence of a minimum, maximum or inflexion point at lower degrees of swelling can be predicted mathematically on this basis. At a sufficiently high degree of swelling, the particles will scatter independently and the 'single-particle curve' is obtained. This is in agreement with the complete disappearance of the inflexion as observed with 'Fiber *G*' in the highest swollen condition.

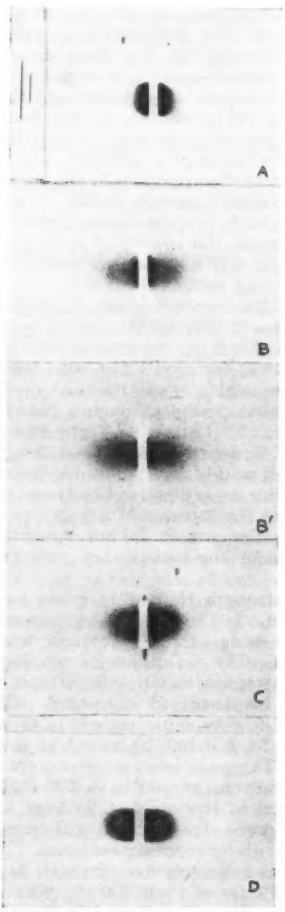


Fig. 1. Small-angle X-ray scattering by 'Fortisan' and 'Fiber *G*'. (*A*) 'Fortisan' in the dry state. (*B*) 'Fortisan' swollen in water. (*B'*) The same. (*C*) 'Fortisan' swollen beyond the water-swollen state. (*D*) 'Fiber *G*' swollen beyond the water-swollen state. Note limited scattering area in *A*; larger area and presence of a maximum in *B* and *B'*, and high intensity and absence of a maximum in *C*. Original size; sample to film distance, 20 cm.

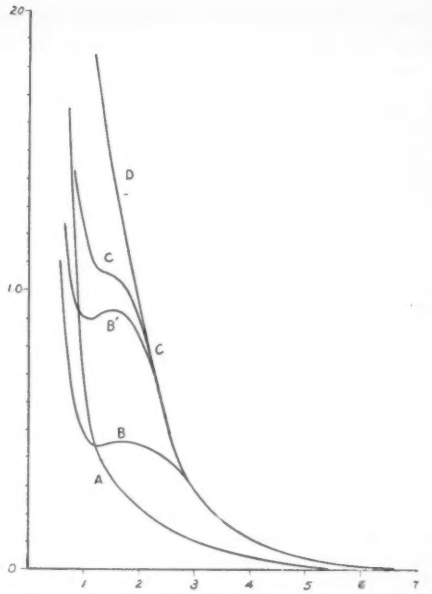


Fig. 2. Distribution of intensity in small-angle scattering by 'Fortisan' and 'Fiber *G*'. Abscissa: angle in 1/100 radians; ordinate; density, which is linearly proportional to intensity. (*A*) 'Fortisan' in dry state. (*B*) 'Fortisan' in water-swollen state. (*C*) 'Fortisan' swollen beyond the water-swollen state. (*D*) 'Fiber *G*' swollen beyond the water-swollen condition; the curve does not show any inflexion point. The curves obtained in other conditions of swelling with 'Fiber *G*' are very similar to those obtained with 'Fortisan' (*A*, *B*, *C*)

From the 'single particle curve' it is possible to determine the size of the scattering particles by plotting the logarithm of the intensity against the square of the scattering angle (see ref. 1, 1950 *b*). If a straight line is obtained, the particle size can be calculated from the slope of this curve. From scattering curves of type *D*, straight-line logarithmic curves were actually obtained, from which a particle size of 45·9 A. was calculated for 'Fortisan' and of 40·6 A. for 'Fiber *G*'. (The value for particle size refers to the diameter of the elongated cylinder supposed to constitute the microcrystallite. If the particle is not cylindrical, the value is a measure of the radius of gyration of the particle around its long axis.) If rayons are investigated under unsuitable experimental conditions (for example, curves of type *A* and *B*) straight-line logarithmic curves are not obtained.

A full account of the above experiments and of small-angle X-ray scattering by rayons in general will be published elsewhere.

A. N. J. Heyn

School of Textiles, Clemson College,
Clemson, South Carolina.

April 15.

[1] Heyn, A. N. J., *J. Amer. Chem. Soc.*, **70**, 3138 (1948); *Text. Res. J.*, **19**, 163 (1949); *J. Amer. Chem. Soc.*, **72**, 2284 (1950 *a*); **72**, 5768 (1950 *b*).

[2] Kriegl, Von H., Kratky, O., and Porod, G., *Z. Elecktrochem.*, **50**, 146 (1952).

[3] Heikens, D., Hermans, P. H., and Weidinger, A., *Nature*, **170**, 369 (1952).

Use of Non-geometrical Perspective in the Two-dimensional Representation of Solid Objects

If a scene be photographed with a camera the lens of which is at a distance D from the negative, it is generally agreed that a print from the developed negative, viewed from the same distance D, may be held up in front of the original scene so that it will then be observed to provide a representation of the original which is 'correct' in perspective. If the print be a transparency and viewed with one eye, points on the original may be seen to be covered exactly by corresponding points on the photographic image.

Such prints are described as giving 'correct perspective' when viewed from the distance D. By photographic 'enlargement' or 'reduction', print dimensions corresponding to multiples (or fractions) of D may be had from the same negative. This is, of course, the usual practice in modern photographic work. For example, prints held in the hand and viewed from a distance of 10–12 in. may thus be obtained in 'correct' perspective, even though the distance D in the camera was much less than this amount.

It is, however, noteworthy that if tests be made away from the original scene with a number of prints of differing degrees of enlargement, the print selected as presenting the most lifelike representation of the original will be not that which gives 'correct perspective' under the particular conditions of viewing, but one which would require to be viewed at a greater distance if 'correct perspective' conditions were to be obtained. This fact is widely exploited by professional photographers, theories of geometrical perspective notwithstanding.

Consideration of an address by Dr. R. H. Thouless[1] provides an explanation of this anomaly. The following quotation, removed from its context, may be inserted here. "If an object is moved to twice its previous distance from our eyes, it does not look half its previous size. It may, for different individuals, look three-quarters of its previous size or nineteen-twentieths. With rare exceptions . . . the apparent size is in between the retinal size and the real size." Hence a two-dimensional print, viewed from a fixed distance, will appear more like the original scene of finite depth when the diminution of scale of reproduction with distance is less than correct geometrical perspective would dictate. This is provided in practice by the use of a print which is viewed at a distance which is less than that necessary for 'correct perspective'. The optimum ratio of enlargement will differ for various individuals; but in theory at least, the ratio could be chosen to give a print which was most generally acceptable as providing an appearance of correct perspective, that is, appearing 'lifelike', under given viewing conditions. These observations should be qualified by certain limitations mentioned in Thouless's address (*loc. cit.*, p. 207).

Similar considerations may provide one reason for the lack of artistic success of art students who attempt drawings of solid objects as if they were exercises in geometrical perspective, measuring up the scene on a pencil held at arm's length.

So far, neither artists nor photographers have been able to explain in terms acceptable to the scientist why representations in correct geometrical perspective are not those most acceptable to the eye, even where they have clearly understood this fact. It would appear, however, that the key to the statement and discussion of the phenomenon in scientific terms has been available for some time.

I am much indebted to Dr. V. R. Pickles for his advice in this matter.

Philip Short

Electrical Engineering Department,
University of Durham, King's College,
Newcastle upon Tyne, 1. July 30.

[1] Thouless, R. H., "Eye and Brain as Factors in Visual Perception". British Association Reports, 1938, Section J (Presidential Address).

Pozzolanic Activity of Ash produced by the Eruption of Mt. Lamington, New Guinea

On January 21, 1951, Mt. Lamington, New Guinea, commenced a series of violently explosive eruptions during which large quantities of steam and ash were ejected. Further explosions occurred on January 27–28 and on February 19, 1951, after which volcanic activity slowly subsided.

Such accumulations of volcanic ashes can be of interest because they may constitute suitable sources of a pozzolanic material. Lea[1] has defined pozzolanas as "siliceous materials which, though not cementitious in themselves, contain constituents which, at ordinary temperatures, will combine with lime in the presence of water to form compounds which have low solubility and possess cementing properties". In recent years much interest has been aroused in the use of pozzolanic materials in mass concrete work. Such materials, blended in suitable proportions with portland cement, not only increase the supply of available cement at very low cost, but also are regarded as improving the durability of concrete.

Samples of Mt. Lamington ash, which were obtained by the Bureau of Mineral Resources, were subjected to examination and to a number of tests to determine their pozzolanic activity. The ash, which had the chemical composition of an andesite, consisted largely of particles that passed through a No. 18 and were held on a No. 150 B.S. sieve. Tests, according to the procedure of Mielenz *et al.*[2], showed that the samples of ash reacted readily with sodium hydroxide solution and that silica was dissolved. These observations indicated that the ash should act as a pozzolana and that fine-grinding, which enhances reactivity, would be necessary for the satisfactory preparation of the pozzolana.

Flexural strength tests were made on small-scale ($\frac{1}{2}$ in. × $\frac{1}{2}$ in. × 4 in.) mortar specimens and, after rupture, the ends of the specimens were tested in compression. The technique of making the specimens, their storage and details of the testing procedure will be described elsewhere. The mortars consisted of a pozzolanic cement and quartz sand (− 25 to + 52 B.S. mesh) mixed in the ratio 1 : 1 by weight. The pozzolanic cement consisted of mixtures of pozzolana (ground to − 300 B.S. mesh) and hydrated lime in the ratio of 2 : 1 by weight. For control purposes lime alone was used in some specimens as the cementing material. The modulus of rupture and compressive strength at ages up to twenty-eight days of the different mortars are given in the table. The material used in pozzolanic mortar *A* was taken from the lower ash layer, that in mortar *B* was from the upper layer.

These results indicate that Mt. Lamington ash possesses pozzolanic properties and that it could be used, at least locally, for blending with portland

Type of mortar	Water : cement ratio	Strength at various ages (days) after fabrication					
		Modulus of rupture (lb./sq. in.)			Compressive (lb./sq. in.)		
		7	14	28	7	14	28
Pozzolana *A*	0·24	433	499	546	3,850	4,100	5,350
Pozzolana *B*	0·24	276	342	503	2,250	3,100	4,450
Lime	0·33	92	83	101	770	730	1,000

cement. The results also suggest that other similar volcanic deposits may be potentially valuable. Further work on the behaviour of blended portland–pozzolana cements is in progress and will be reported elsewhere.

We are indebted to Dr. H. G. Raggatt, former director, to Dr. N. H. Fisher, chief geologist, to Mr. A. H. Debnam and to other officers of the Bureau of Minerals Resources for securing the samples of ash from Mt. Lamington and for chemical analyses.

K. M. Alexander
H. E. Vivian

Cement and Ceramics Section,
Division of Industrial Chemistry,
Commonwealth Scientific and
Industrial Research Organization,
Fishermen's Bend,
Melbourne.

[1] Lea, F. M., Symposium on the Chemistry of Cements, Stockholm, 460 (1938).
[2] Mielenz, R. C., Greene, K. T., and Benton, E. J., *J. Amer. Concrete Inst.*, **19**, 193 (1947).

Amino-Acids and the Growth of Isolated Oat Embryos

There have been numerous reports of interactions between amino-acids in their effects on the growth of bacteria and fungi, while relatively few interactions of this type have been reported in studies with higher plants. Mixtures of amino-acids have been found to interact in their effects on the growth of immature *Datura* embryos[1]. Antagonisms have been reported between canavanine and structurally related amino-acids in their effects on the growth of *Avena* coleoptile sections[2] and immature embryos of maize[3]. Experiments reported here extend these observations in so far as they expose a series of interactions between amino-acids in their effects on the growth of mature embryos of oat. These interactions have been observed as antagonisms between individual amino-acids in their effects on root growth.

Embryos of oat (var. Victory) were grown in sterile culture in the dark at a temperature of 25 ± 1° C. Each embryo was grown in a separate culture vessel, in which it was supported at the surface of 50 ml. of liquid medium. The basal medium, to which the amino-acids under test were added, contained: (1) inorganic salts as used by Burström[4] for the culture of excised roots of wheat but with potassium chloride and calcium chloride substituted for the corresponding nitrates and with ferric sulphate omitted; (2) organic growth factors as used by White[5] for the culture of excised roots but with glycine omitted; (3) 0·2 *M* sucrose. The initial *p*H of all media was adjusted to a value of 6·2 ± 0·2 by the addition of suitable quantities of 0·01 *N* sodium hydroxide. The media were sterilized by autoclaving at a pressure of 15 lb. for five minutes.

It was found that the total linear growth of the embryos could be substantially increased by the addition of a vitamin-free casein hydrolysate to the basal medium. The effect of the hydrolysate could be simulated by supplying a synthetic mixture of eighteen amino-acids in its place. The effect of twelve of these amino-acids was studied by supplying them alone and in pairs, at the same concentrations as those used in the mixture. The table shows the effects of the amino-acids supplied alone (Exp. 1) and in combination with phenylalanine (Exp. 2) and with valine (Exp. 3) on the growth in length of the roots. When supplied alone, eleven out of the twelve amino-acids were inhibitory to root growth, while one, arginine, had little effect. In the majority of cases where amino-acids were supplied in pairs, the pair proved to be less inhibitory to root growth than was the most inhibitory of its constituent amino-acids supplied alone. In certain instances interactions were very marked. Phenylalanine was particularly effective as an antagonist for tyrosine and also showed marked interactions with serine and with threonine. Valine, which was the most inhibitory of the amino-acids when supplied alone, was effective in relieving the inhibition of growth produced by leucine and by isoleucine. These two interactions involving valine were striking in that the growth value obtained with the combination of acids exceeded that obtained with either alone.

The Effect of Amino-Acids Supplied Alone and in Combination with Phenylalanine and with Valine on the Length of the Roots of Isolated Oat Embryos Measured at the End of a Seven-day Culture Period. All Values are Based on the Means of Measurements Made on at Least Ten Seedlings

Amino-acid	Conc. mgm./l.	Length of roots as percentage of control (basal medium) in each experiment		
		Exp. 1. No addition	Exp. 2. Addition of L-phenylalanine, 17·5 mgm./l.	Exp. 3. Addition of DL-valine, 35·2 mgm./l.
None	—	100	70	14
L-Arginine	17·5	106	86	23
L-Phenylalanine	17·5	72	—	22
L-Aspartic acid	26·3	66	79	20
L-Glutamic acid	87·6	64	58	20
L-Proline	35·2	47	62	28
L-Lysine 2HCl	30·4	39	33	18
DL-Threonine	17·5	30	59	25
L-Leucine	21·9	29	37	41
DL-Isoleucine	21·9	28	42	44
L-Tyrosine	26·3	27	64	23
DL-Serine	26·3	21	45	17
DL-Valine	35·2	15	22	—
Length of roots in basal medium (control) in mm.		317	308	304

The results of further experiments have confirmed the existence of a marked interaction between DL-valine and DL-isoleucine and have indicated that no similar interaction occurs between DL-isoleucine and L-leucine. Evidence has also been obtained for interactions between glycine and DL-serine and between L-arginine and L-lysine.

I wish to express sincere thanks to Dr. H. E. Street, under whose direction this work was carried out in the Department of Botany, University of Manchester.

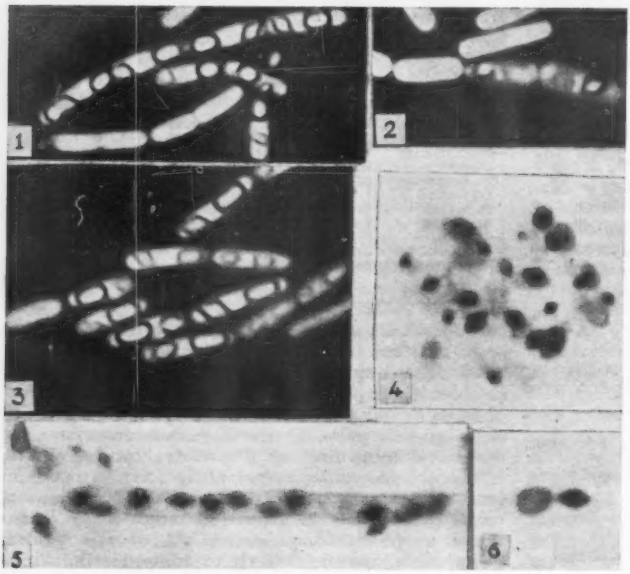
G. P. Harris

Department of Botany,
University of Otago,
New Zealand.
Oct. 19.

[1] Sanders, M. E., and Burkholder, P. R., *Proc. U.S. Nat. Acad. Sci.*, **24**, 516 (1948).
[2] Bonner, J., *Amer. J. Bot.*, **36**, 323 (1949).
[3] Wright, J. E., and Srb, A. M., *Bot. Gaz.*, **112**, 52 (1950).
[4] Burström, H., *Bot. Not.*, 310 (1941).
[5] White, P. R., "A Handbook of Plant Tissue Culture" (The Ronald Press Company, New York, 1943).

Crystalline Inclusions in Aerobic Spore-forming Bacteria

B. thuringiensis Berliner[1] is an aerobic spore-forming bacillus, classified by Smith, Gordon and Clark[2] as *Bacillus cereus* var. *thuringiensis*, because apart from its pathogenicity for certain insects and the tendency of the spores to lie obliquely in the cell, the organism is indistinguishable from *B. cereus*.



(1) *B. thuringiensis*. Air-mounted nigrosin film. Unstained. Robinow's technique (ref. 5). × 2,400
(2) Crystal-bearing cell of *B. thuringiensis* in which the spores have lysed before reaching maturity. × 2,400
(3) Crystals and spores in Bacillus No. 1. A constituent of 'Sporeine' powder which is pathogenic for *Ephestia kühniella* Zell. Jacobs (ref. 6). × 2,400
(4) Free crystals and spores of *B. thuringiensis*. Hydrolysed at room temperature in *N*/3 nitric acic containing 0·1 per cent potassium permanganate (Method 2. Robinow, ref. 7). Stained with crystal violet and photographed mounted in water. × 2,400
(5) Crystals alternating with spores in a chain of *B. thuringiensis*. Hydrolysed in hydrochloric acid at 60° C. for 15 min. and stained with crystal violet. Photographed mounted in water. × 2,400
(6) Crystal attached to free spore. Stained with crystal violet and photographed mounted in water. × 3,600

During a study of spore formation in this organism, it was noted that the spores were invariably accompanied by what appeared to be diamond-shaped crystals (Fig. 1). Each cell contained only one crystal, and the order in a chain of cells was random. The crystals vary a great deal in size (Fig. 4) but are always the same shape, and are set free with the spores and persist indefinitely. Occasionally a crystal may be firmly attached to a spore (Fig. 6). Lysis may occur in the early stages of spore formation so that a cell may contain a crystal but no spore (Fig. 2).

Cultures of spore-forming insect pathogens (variants of *B. cereus*) from other sources have been examined and it has been found that the majority form crystals on sporulation (Fig. 3). All strains of *B. cereus* that were obtained from other sources and which were not known to be pathogenic for insects, together with strains isolated from soil and foodstuffs, failed to form crystals on sporulation.

The crystals stain readily with Giemsa but more intensely with basic fuchsin and crystal violet, and most cleanly with Victoria blue. With the acid dye ponceau de xylidine dissolved in *N*/10 hydrochloric acid they stain a pale orange-red. After hydrolysis in *N* hydrochloric acid at 60° for 15 min. or in *N*/3 nitric acid with 0·1 per cent potassium permanganate, the crystals both free and within the cells are unaltered in size and shape and take up the stain more easily than before hydrolysis (Figs. 4 and 5).

The crystals are readily soluble in dilute alkali but are insoluble in water, physiological saline, ethanol, methanol, chloroform, ether, benzene and acetone. When dilute alkali is run under an air-dried coverslip preparation of crystals and spores, the crystals, while still retaining their shape, greatly increase in size, then lose their refractility and finally disappear, leaving behind a thin shell or membrane.

A biological phenomenon in which crystalline inclusions have only been found in strains of bacteria pathogenic for insects must inevitably, in the absence of additional observations, lead to some speculation as to the possible association of inclusions with pathogenicity. The crystals have certain features in common with the nuclear polyhedral crystalline inclusion bodies as elucidated by Bergold[3]; but their ability to take up stains is similar to the cytoplasmic inclusion bodies of Smith and Xeros[4]. They differ, however, in that so far as has been observed, only one crystal is formed in each cell. At the moment nothing is known about their composition, whether they contain a virus or phage, or whether the crystal formation is a genetical characteristic of the organism which is in some way connected with the formation of a toxic substance encouraging septicæmia of the insect larvæ.

C. L. Hannay
Science Service Laboratory,
University Sub-Post Office,
London, Ontario. Sept. 29.

[1] Berliner, E., *Z. gesam. Getreidewesen*, **3**, 63 (1911).
[2] Smith, N. R., Gordon, R. E., and Clark, F. E., U.S. Depart. Agric., Mon. No. 16 (1952).
[3] Bergold, G. H., *Biol. Zentr.*, **63**, 1 (1947).
[4] Smith, K. M., and Xeros, N., *Parasit.*, **43**, 178 (1953).
[5] Robinow, C. F. (personal communication).
[6] Jacobs, S. E., *Proc. Soc. App. Bact.*, **13**, 83 (1950).
[7] Robinow C. F., *J. Gen. Microbiol.*, **5**, 439 (1951).

Acetylcholine in Blowflies

A study of two species of blowfly, *Calliphora erythrocephala* and *Lucilia sericata*, has shown that a rapid synthesis of an acetylcholine-like substance can take place in extracts prepared from these insects. This synthesis, which occurs in the absence of additional substrate, may account for some of the high concentrations of acetylcholine which have been previously reported in insects[1–3].

Flies were immobilized by cooling at 0° C., weighed, and extracts prepared according to one of the following methods: (*A*) grinding in a Potter–Elvehjem homogenizer[4] with Ringer solution containing 0·001

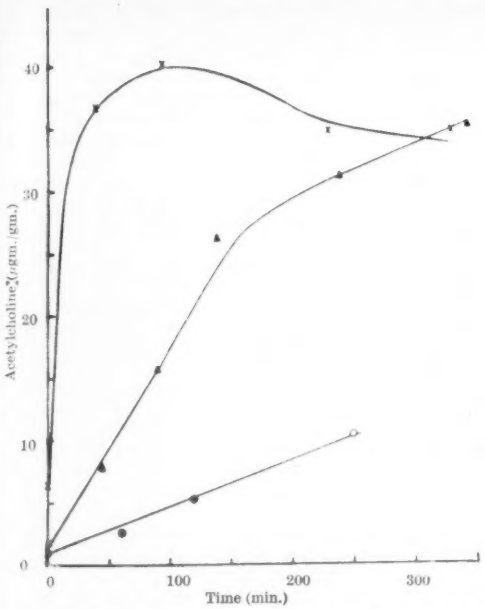


Fig. 1. Synthesis of acetylcholine in extracts from *Lucilia sericata*: ▲—▲—, whole insect; ×—×—, head (0·05 per cent eserine); ○—○—, thorax

per cent eserine sulphate and acidified with 0·33 *N* hydrochloric acid, followed by boiling as described by Feldberg[5]; (*B*) homogenizing with non-acidified Ringer solution containing either 0·001 or 0·05 per cent eserine sulphate, using 1 ml. Ringer/100 mgm. fly tissue. In each case the homogenate was centrifuged to remove chitin and tissue debris. The acetylcholine content was then assayed immediately or after incubation at 18° C., using the frog rectus abdominus muscle preparation, allowance being made for the presence of sensitizing substances in the extract as recommended by Feldberg[6]. Results obtained with extracts prepared according to method *A* are given in Table 1.

When tissue extracts were prepared by method *B*, the acetylcholine content was much greater, and increased rapidly on incubation (Fig. 1). In a sample taken 45 min. after homogenizing and boiled for 1 min., the acetylcholine content remained constant at 7·5 μgm./gm., while in the incubated extract it increased to 35 μgm./gm. in 350 min.

Supporting evidence for the identity of the substance synthesized in the fly extracts has been obtained by chromatographic analysis. An incubated extract was deproteinized with 10 per cent trichloracetic acid, and the supernatant extracted with ether and concentrated *in vacuo* at 40° C. The concentrate was extracted with ethanol and the extract again concentrated *in vacuo*. Two equal portions were taken and 15 μgm. acetylcholine added to one of them. Both portions were then run on

Table 1. Acetylcholine Content of Extracts from Flies
(μgm./gm. tissue, fresh weight)

	Calliphora	*Lucilia*
Whole insect	1·7	1·8
Head	6·4	6·3
Thorax	—	1·0
Abdomen	—	<0·25

Table 2. Acetylcholine in Extracts from Flies treated with DDT
(μgm./gm. tissue, fresh weight)

Incubation time (min.)	Untreated insects	Insects treated with DDT (time after treatment)	
		1 hr.	4·5 hr.
35	—	16	—
75	31	—	60
150	41	26	80

Whatman No. 4 paper using the *n*-propanol/formic acid/water mixture described by Whittaker and Wijesundera[7]. The chromatogram was cut into ten sections, and each section eluted with 10 ml. Ringer solution and the eluates then assayed on the muscle preparation. The results showed no detectable separation of the active material in the extract from the acetylcholine added.

Tobias *et al.*[3] have shown that there is a considerable increase in the acetylcholine content of flies after poisoning with DDT. They found 47 μgm./gm. in normal flies (*Musca domestica*), whereas DDT-poisoned flies examined at the prostrate stage contained 131 μgm./gm. The methods used by these workers would not have excluded the possibility of synthesis occurring in the extract, and therefore this effect was re-investigated. Adult flies (*Calliphora erythrocephala*) were confined for 10 min. in a glass cylinder coated with DDT. Symptoms of poisoning developed rapidly and the insects were prostrate in about 4 hr. At this time the synthesis in extracts prepared from these flies by method *B* was found to be much greater than in extracts prepared from control flies. In extracts prepared from flies showing intense activity 1 hr. after treatment with DDT, the synthesis was less than in the controls. The results in Table 2 show the amounts synthesized in extracts prepared from heads and thoraces at 1 hr. and 4·5 hr. after DDT treatment.

These results suggest that the large increase in acetylcholine in flies poisoned with DDT and at the prostrate stage is due to an increased rate of synthesis in the extract which is not necessarily related to the acetylcholine content of the insect.

There is, however, a small increase in the biological activity of extracts prepared by method *A* from flies poisoned with DDT. The increase was equivalent to less than 0·5 μgm./gm. and could be demonstrated in flies only 20 min. after exposure to DDT; it is therefore not due to a rapid synthesis occurring during the preparation of the homogenate. This increase in biological activity has also been demonstrated in flies which were killed by immersion in liquid nitrogen 20 min. after treatment with DDT. In this case the frozen insects were homogenized in 10 per cent trichloracetic acid and the extract assayed after removal of the acid with ether. The nature of the substance remains to be investigated.

This work was carried out while on leave from the Pest Infestation Laboratory, Slough, and I wish to thank Dr. T. Mann for his advice and interest.

S. E. Lewis

Molteno Institute,
University of Cambridge. Aug. 5.

[1] Corteggiani, E., and Serfaty, A., *C.R. Soc. Biol.*, **131**, 1124 (1939).
[2] Mikalonis, S. J., and Brown, R. H., *J. Cell. Comp. Physiol.*, **18**, 401 (1941).
[3] Tobias, J. M., Kollros, J. J., and Savit, J., *J. Cell. Comp. Physiol.*, **28**, 159 (1946).
[4] Potter, V. R., and Elvehjem, C. A., *J. Biol. Chem.*, **114**, 495 (1936).
[5] Feldberg, W., *J. Physiol.*, **101**, 432 (1943).
[6] Feldberg, W., *J. Physiol.*, **103**, 367 (1945).
[7] Whittaker, V. P., and Wijesundera, S., *Biochem. J.*, **51**, 348 (1952).

Detection of Fœtal and Sickle-cell Hæmoglobins in Human Anæmias

We have systematically examined a large number (175) of normal and anæmic bloods for the presence of fœtal hæmoglobin (F-Hb)[1] by three methods: (*a*) the position of the tryptophan fine-structure band[2], using the moving-plate method of Holiday[3], from which the relative proportions of adult (A-Hb)[1] and fœtal hæmoglobin can be estimated[4] when more than 10 per cent of the latter is present, though smaller proportions cannot be detected; (*b*) the Rich 'slope' method[5], using the Unicam *SP.*500 spectrophotometer, which has the same order of sensitivity; (*c*) the rate of alkaline denaturation at *p*H 12·8, which provides a sensitive means of detecting the more alkaline-resistant fœtal hæmoglobin[6].

A photoelectric colorimeter is used for measuring the rate of increase of absorbance (optical density) at 640 mμ due to the formation of alkaline hæmatin, and the observations are treated as a first-order process. Normal adult hæmoglobin shows a single component with half-reaction time ($t_{\frac{1}{2}}$) at 20° of 11·3 sec. (S.D. 2·3), whereas at birth cord-blood contains 70–80 per cent of fœtal hæmoglobin with $t_{\frac{1}{2}}$ of the order of 10^3 sec. As little as 2 per cent of fœtal hæmoglobin can be detected by 'tailing' of the main slope, and when more than 7 per cent is present, a good estimate of the fœtal component can be obtained by extrapolation.

The presence of sickle-cell hæmoglobin (S-Hb)[1] is readily determined by measurement of the solubility of the reduced hæmoglobin in *p*H 6·7 phosphate buffer at ionic strengths ($\Gamma/2$) between 3·84 and 5·45[7]. Regression lines differing in height on the (log) solubility axis but not in slope have been obtained for the solubility of normal adult hæmoglobin and for the mixed hæmoglobins from sickle trait and sickle-cell anæmia erythrocytes. At $\Gamma/2 = 4{\cdot}75$, the mean solubilities for hæmoglobins from the three groups were 6·38, 2·00 and 0·66 gm./litre respectively. (The greater proportion of sickle-cell hæmoglobin in sickle-cell anæmia erythrocytes, as compared with sickle trait erythrocytes, is presumably the explanation for the higher birefringence of the former after reduction.)

The three methods for detection of fœtal hæmoglobin are very reliable when used in conjunction. The 70–80 per cent of fœtal hæmoglobin present at birth is rapidly replaced by adult hæmoglobin during the first four months of life. Blood from cases of acute leukæmias, erythro-leukæmia, myelosclerosis, paroxysmal nocturnal hæmoglobinuria, aplastic, hypochromic and megaloblastic anæmias, and from a target-cell anæmia in liver disease, has been examined; also from a wide variety of familial hæmolytic anæmias associated with spherocytosis or ovalocytosis, or in various atypical forms[8]. The great majority has contained only adult hæmoglobin, or not more than a trace of fœtal hæmoglobin (less than 3 per cent, and this detectable by the alkaline denaturation method only). However, in one child of three years with acute paramyeloblastic leukæmia, 10–20 per cent of fœtal hæmoglobin was present.

In Mediterranean and sickle-cell anæmias fœtal hæmoglobin may be encountered more frequently[8,9,10]. We have found 12–20 per cent of fœtal hæmoglobin in the erythrocytes of a Cypriot child of three years; this child's parents' cells, and those of two other Mediterranean traits, contained only the adult form. In sickle-cell anæmia, we have encountered 20 per cent of fœtal hæmoglobin persisting in a child of one year, but none in a further five cases in adults or in sixteen cases with the sickle trait. Both parents of individuals with anæmia of sickle-cell type do not always carry the sickle trait, but one may carry the Mediterranean or some other trait[10]. In our work, erythrocytes from three affected offspring from three such families were found to contain 20 per cent, 3 per cent and no fœtal hæmoglobin.

It appears that the presence of fœtal hæmoglobin after infancy is associated with the hereditary Mediterranean, sickle-cell and related diseases. In other hereditary hæmolytic conditions, and in severe blood dyscrasias, even those with extra-medullary hæmopoiesis, the hæmoglobin is most usually of the normal adult type.

We are grateful to many colleagues for blood samples. A fuller account will appear elsewhere.

G. H. Beaven
Medical Research Council Spectrographic Unit,
London Hospital,
London, E.1.

J. C. White
Department of Pathology (Hæmatology),
Postgraduate Medical School of London,
London, W.12.

Aug. 12.

[1] *Blood*, **8**, 386 (1953).
[2] Jope, E. M., "Hæmoglobin: Barcroft Memorial Volume", 205 (edit. by F. J. W. Roughton and J. C. Kendrew. London, 1949).
[3] Holiday, E. R., *J. Sci. Instr.*, **14**, 166 (1937).
[4] Beaven, G. H., Hoch, H., and Holiday, E. R., *Biochem. J.*, **49**, 374 (1951).
[5] Rich, A., *Proc. U.S. Nat. Acad. Sci.*, **38**, 127 (1952).
[6] Jonxis, J. H. P., "Hæmoglobin: Barcroft Memorial Volume", 261 (London, 1949).
[7] Perutz, M. F., and Mitchison, J. M., *Nature*, **166**, 677 (1950). Perutz, M. F., Liquori, A. M., and Eirich, F., *Nature*, **167**, 929 (1951). Jope, H. M., and O'Brien, J. R. P., "Hæmoglobin: Barcroft Memorial Volume", 269 (London, 1949).
[8] Dacie, J. V., Mollison, P. L., Richardson, N., Selwyn, J. G., and Shapiro, L., *Quart. J. Med.*, N.S., **22**, 79 (1953).
[9] Liquori, A. M., *Nature*, **167**, 950 (1951). Singer, K., Chernoff, A. I., and Singer, L., *Blood*, **6**, 413, 429 (1951).
[10] Itano, H. A., *Science*, **117**, 89 (1953).

Prevention and Cure of Enzootic Muscular Dystrophy in Beef Cattle

Investigations carried out in collaboration with the veterinary investigation officers in Scotland have shown that a muscular dystrophy of suckling beef calves is quite commonplace. In Inverness and adjoining counties it appears that the disease occurs on some 15–25 per cent of all farms rearing beef cattle, and that the incidence on these farms may occasionally approach 90 per cent. Studies of the gross and microscopic pathology have shown the disease to be very closely comparable to both experimental vitamin E deficiency[1] and the cod-liver oil toxicity syndrome[2,3] of calves. Furthermore, analyses of the feeding-stuffs making up the winter rations of the cows in these areas indicate that the intake of α-tocopherol is very low[4]. The disease almost invariably occurs in calves born indoors in spring to mothers which have been housed since the previous autumn.

Experiments, which have now been carried out on twenty 'susceptible' farms in the vicinity of Inverness, show that vitamin E will prevent the disease. On each farm half the cows were given α-tocopheryl acetate before parturition, and the remainder were

INCIDENCE OF DYSTROPHY IN GROUPS OF 42 CALVES ON 20 FARMS

	Dam received no tocopherol before calving		Dam received tocopherol before calving	
	Calf not treated	Calf given tocopherol	Calf not treated	Calf given tocopherol
Total No. of cases	11	3*	2	0
Deaths	3	0	0	0
Slight involvement only	3	3	2	0

* Dystrophy was diagnosed before the third day of life, that is, prior to treatment of the calf with tocopherol. It receded when tocopherol was given.

not treated. The calves born to these two groups were again subdivided, half receiving α-tocopheryl acetate and half none. The incidence of dystrophy, including deaths due to cardiac failure associated with degeneration of the myocardium, is summarized in the accompanying table.

No cases were observed in the group in which both dam and calf received tocopherol; but an incidence of more than 25 per cent occurred in the groups which received none at any time. In calves which died, dystrophic lesions were found and the creatine content of the muscles was depressed. When diagnosis was unequivocal, treatment of the calves was instituted, with complete recovery in all cases. Further field observations have also shown treatment, if commenced in the early stages, to be completely effective.

Studies of blood tocopherol concentration have shown that on farms where the disease is severe the concentration of tocopherols in the serum was less than 40 μgm./100 ml., which is considerably below the normal value of more than 150 μgm./100 ml. found in normal healthy calves in Ayrshire.

Full details of these experiments will be published elsewhere. We are indebted to Roche Products, Ltd., for gifts of some of the tocopherol used in these studies and to our colleagues for their assistance.

K. L. BLAXTER

Hannah Dairy Research Institute,
Kirkhill, Ayr.

G. A. M. SHARMAN

North of Scotland College of Agriculture,
Veterinary Investigation Laboratory,
3 Union Street, Inverness.
Aug. 5.

[1] Blaxter, K. L., Watts, P. S., and Wood, W. A., *Brit. J. Nutr.*, **6**, 125 (1952).
[2] Blaxter, K. L., Wood, W. A., and MacDonald, A. M., *Brit. J. Nutr.*, **7**, 34 (1953).
[3] Blaxter, K. L., Brown, F., and MacDonald, A. M., *Brit. J. Nutr.*, **7**, 287 (1953).
[4] Brown, F., *J. Sci. Food Agric.*, **4**, 161 (1953).

Linkage between Pulmonary Tumours and Vestigial Tail in the House Mouse

THE occurrence of pulmonary tumours in the mouse has been shown to be controlled by multiple genetic and non-genetic factors, the tumours appearing when the combined effect of these factors surpasses a physiological threshold[1]. Tests for linkage[2,3] have demonstrated association between the occurrence of pulmonary tumours and the genes, lethal yellow (*A^y*), flexed tail (*f*), hairless (*hr*), and the linked genes shaker-2 (*sh*-2) and waved-2 (*wa*-2). There was evidence that the relationship to *A^y* was due to the positive effect of the gene itself upon susceptibility to this type of tumour. Whether or not the relationship to the other genes represented true linkage was not ascertained; but certain evidence suggested secondary effects.

Recently, tests have been made for linkage between pulmonary tumours and vestigial tail (*vt*), a new recessive mutation that arose in this laboratory[4]. During this time, Michie[5] has located *vt* in linkage group VII within a few units of *sh*-2 and about 19 units from rex (*Re*). This would place *vt* about 35 units from *wa*-2, which is on the other side of *sh*-2 from *Re*. Results reported herein indicated an association between occurrence of pulmonary tumours and *vt*, and are in line with Michie's evidence of close linkage between *vt* and *sh*-2 and with the preceding demonstration of association between pulmonary tumours and *sh*-2.

This test utilized backcross mice produced by mating three strain *A* females to the vestigial-tailed male and backcrossing the F_1 males and females to vestigial. In strain *A* mice eighteen months of age, the incidence of pulmonary tumours is 90 per cent, which is the highest incidence reported for any strain. Following the intravenous injection of 0·5 mgm. of 1 : 2 : 5 : 6 dibenzanthracene, pulmonary tumours occur in all mice of this strain at six weeks of age, and at sixteen weeks there is an average of 75 tumours in the lungs of each. The vestigial-tailed mice were of a stock developed through vestigial × vestigial matings of hybrids of the original analysis of the trait[4].

Two hundred and two of the backcross animals divided approximately equally between + *vt* and *vt vt*, and as to sex, were tested for degree of susceptibility to pulmonary tumour development by injecting each intravenously at two months of age with 0·5 mgm. of 1 : 2 : 5 : 6 dibenzanthracene dispersed in 0·5 c.c. horse serum. At eight months of age, each animal was killed and the number of tumours appearing on the pleural surface was recorded. The number of tumours has proved to be a sensitive quantitative measure of degree of susceptibility used in demonstrating differences due to genes or other biological factors and also chemical factors. As shown in Table 1, the normal tailed (+ *vt*) segregants were more susceptible to pulmonary tumours than were the vestigial-tailed (*vt vt*) segregants. The mean number of tumours in the two groups of + *vt* males combined was 10·5, whereas that for the two groups of *vt vt* males combined was 4·0. The difference between these means is highly significant; $t = 4{\cdot}26$; $P < 0{\cdot}01$. The mean number in the two groups of + *vt* females combined was 16·0 and that for the two groups of *vt vt* females combined was 8·96; the

Table 1. OCCURRENCE OF PULMONARY TUMOURS IN THE SEGREGATED BACKCROSS HYBRIDS

Genotype and sex	Sex of F_1 parent	Total mice	Mice with given No. of tumours				Mean No. of tumours
			0	1–10	11–20	21+	
Vt vt ♂	♂	35	2	16	8	9	12·8
Vt vt ♂	♀	15	2	13	0	0	4·7
vt vt ♂	♂	45	8	31	5	1	4·6
vt vt ♂	♀	11	5	5	0	0	1·1
Vt vt ♀	♂	38	0	14	10	14	17·5
Vt vt ♀	♀	8	0	6	1	1	8·1
vt vt ♀	♂	40	3	23	10	4	9·8
vt vt ♀	♀	11	1	8	1	1	5·0

difference between these means is likewise highly significant; $t = 3{\cdot}31$; $P < 0{\cdot}01$. Thus, an association between susceptibility to induced pulmonary tumours and *vt* is clearly established.

In former tests it had been suggested that the decrease in both spontaneous and induced pulmonary tumours associated with *sh*-2 and *wa*-2 was due to *sh*-2 itself. No difference in occurrence of pulmonary tumours had been noted when *wa*-2 had been tested in the absence of *sh*-2. Furthermore, there was a positive correlation between increased body-weight and increased occurrence of pulmonary tumours, and certain genes, including *sh*-2, and other factors affecting body-weight were shown to be associated with a similar effect upon occurrence of pulmonary tumours. Contrary to this former suggestion, true linkage is now indicated. In the present tests *sh*-2 was not involved and, furthermore, *vt vt* did not reduce body-weight more than could have been expected from the absence of most of the tail. This would indicate a gene (or genes) influencing susceptibility located in linkage group VII at a locus near enough to *sh*-2 and *vt* to result in a difference in backcross segregants, but possibly so far from *wa*-2 that its effect was not detected in the test involving *wa*-2 alone. It is possible, however, that in the test of *wa*-2 alone the parental stocks were alike in respect to this susceptibility gene or these genes.

In the backcross hybrids of this test there was a sex difference in susceptibility to induced pulmonary tumours in that the females had on the average more tumours than the males. The mean number of tumours in all + *vt* females was 16·0, as compared with a mean number of 10·5 in all + *vt* males. The difference between these means is highly significant; $t = 2{\cdot}38$; P is between 0·01 and 0·02. Furthermore, the mean number of tumours in all *vt vt* females was 9·0 and that in all *vt vt* males was 4·0; the difference between these two means is also highly significant; $t = 3{\cdot}91$; $P < 0{\cdot}01$. In many former tests of strain *A* mice and their hybrid derivatives, sex differences have not been observed, whereas in certain groups of mice of other strains and hybrids of various types, sex differences have been observed; but in these cases the males have been more susceptible than the females[6].

In the present backcross segregants it was also noted that more tumours occurred in mice from matings of F_1 males × *vt vt* females than in those from F_1 females × *vt vt* males. This is of doubtful significance, however, inasmuch as there may have been genetic variation in the *vt vt* mice in respect to pulmonary tumours which could account for more tumours in progeny of F_1 males, especially since only two F_1 males were used in the backcross matings.

W. E. Heston

National Cancer Institute,
National Institutes of Health,
Bethesda 14,
Maryland.

[1] Heston, W. E., *J. Nat. Cancer Inst.*, **3**, 69 and 79 (1942).
[2] Heston, W. E., *J. Nat. Cancer Inst.*, **2**, 127 (1941); **3**, 303 (1942). Heston, W. E., and Deringer, M. K., *J. Nat. Cancer Inst.*, **7**, 463 (1947); **10**, 119 (1949); **12**, 361 (1950). Heston, W. E., Deringer, M. K., Hughes, I. R., and Cornfield, J., *J. Nat. Cancer Inst.*, **12**, 1141 (1952).
[3] Burdette, W. J., *J. Thoracic Surgery*, **24**, 427 (1952).
[4] Heston, W. E., *J. Hered.*, **42**, 71 (1951).
[5] Michie, D., *Nature*, **170**, 585 (1952).
[6] Deringer, M. K., and Heston, W. E., *J. Nat. Cancer Inst.*, **14** (1953).

Transphosphorylation between Nucleoside Polyphosphates

During an investigation of the mechanism of phosphorylation of glucose by nucleoside triphosphates we have observed the transfer of the terminal phosphate group of adenosine triphosphate to inosine diphosphate. The reaction can be formulated as follows:

$$ATP + IDP \rightleftharpoons ADP + ITP. \quad (1)$$

This reaction is catalysed by an enzyme present in baker's and brewer's yeast and in extracts of rabbit muscle. It has been directly demonstrated in the following manner: adenosine triphosphate equally labelled in both labile phosphate groups with phosphorus-32 was incubated with inosine diphosphate and a dialysed protein fraction from brewer's yeast. The appearance of radioactivity in the inosine polyphosphate fraction was determined after separating it from adenosine di- and tri-phosphate by paper ionophoresis at *p*H 3·5 in *M*/50 citrate buffer. The results of a typical experiment are shown in Table 1. Also included is an experiment in which inosine triphosphate was the labelled substrate.

Table 1. Transfer of Phosphate from Nucleoside Triphosphate to Nucleoside Diphosphate

Exp. No.	Labelled substrate	Time (min.)	Radioactivity (counts/min.)		Percentage transfer of P
			ATP + ADP	ITP + IDP	
A	ATP	0	13,300	116	—
		5	12,500	930	6·9
		10	12,300	1,210	9·0
		20	9,700	1,740	15·0
		60	10,200	2,760	21·2
		120	9,400	2,640	21·4
B	ITP	0	310	5,580	—
		20	1,920	4,770	28·3
		40	2,140	4,550	32·0
		160	1,970	4,800	29·1

The reaction mixture for experiment *A* contained: *M*/10 *tris*-hydroxymethyl aminomethane buffer, *p*H 8; *M*/60 magnesium chloride; *M*/150 phosphorus-32-labelled adenosine triphosphate; *M*/150 inosine diphosphate; 1 mgm. yeast protein fraction; total volume, 1·0 ml. For experiment *B*: *M*/10 *tris*-hydroxymethyl aminomethane buffer *p*H 8; *M*/60 magnesium chloride; *M*/500 phosphorus-32-labelled inosine triphosphate; *M*/500 adenosine diphosphate, 0·5 mgm. yeast protein fraction; total volume, 1·0 ml.

It can be seen that reaction (1) could result from the transfer of an amino group as well as of a phosphate group. To distinguish between these two possibilities, each of the four components was isolated after an experiment similar to *A* in Table 1. The fractions containing adenosine and inosine were first separated as described above and then subjected to paper ionophoresis at *p*H 4·7 in order to separate the di- and tri-phosphates. The results obtained, together with the values predicted for either type of mechanism, are presented in Table 2. It is clear from the results that the reaction is a transphosphorylation.

The reversibility of reaction (1) is demonstrated by the ability of inosine triphosphate to phosphorylate adenosine diphosphate (experiment *B*, Table 1). In experiment *A* the reaction proceeds until the amount of radioactive phosphate incorporated into the inosine polyphosphate fraction approaches a quarter of that originally present in both labile phosphate groups of adenosine triphosphate. The reaction in the opposite direction (experiment *B*) approaches a similar limiting value. Since in both cases the initial nucleoside triphosphate was labelled equally in both labile phosphates, and the newly formed triphosphate contained only one labelled

Table 2. DETERMINATION OF THE SPECIFIC ACTIVITY OF THE COMPONENTS OF THE REACTION
(Figures represent counts per min./micromole)

Compound isolated	Theoretical for Transamination	Theoretical for Transphosphorylation	Formed
ATP	1,920	1,920	1,920
IDP	0	0	0
ADP	0	960	1,045
ITP	1,920	960	930

The reaction mixture contained *M*/10 *tris*-hydroxymethyl aminomethane buffer pH 8; *M*/50 magnesium chloride; *M*/150 phosphorus-32-labelled adenosine triphosphate; *M*/150 inosine diphosphate; 0·25 mgm. yeast protein fraction; total volume, 0·65 ml.

phosphate (Table 2), the equilibrium constant of the reaction is approximately 1.

The reaction is specific for nucleoside triphosphates as donors and nucleoside diphosphates as acceptors. Nucleoside monophosphates do not participate in the reaction. We therefore propose the name 'nucleoside diphosphokinase' for the new enzyme.

The transphosphorylation reaction can also be demonstrated spectrophotometrically. In the presence of yeast hexokinase[1] and a preparation of glucose-6-phosphate dehydrogenase[2,3], which contains 'nucleoside diphosphokinase', the rate of phosphorylation of glucose by inosine triphosphate (as measured by reduction of triphosphopyridine nucleotide at 340 mμ [4]) is markedly increased by catalytic amounts of adenosine diphosphate and approaches the rate found with adenosine triphosphate. A similar effect is seen if the new nucleoside triphosphate, uridine triphosphate[5], is used as the phosphate donor. The results of an experiment with the latter are shown in Fig. 1. It is seen that, as in the case with inosine triphosphate, the rate of phosphorylation of glucose by uridine triphosphate alone is very slow. On the addition of adenosine diphosphate, however, there is an immediate rapid reaction. The increase in absorption at 340 mμ has been adapted for use as a quantitative measure of uridine triphosphate. We have assayed a synthetic preparation of uridine triphosphate, kindly furnished by Prof. A. R. Todd, and the value obtained was in agreement with the estimate

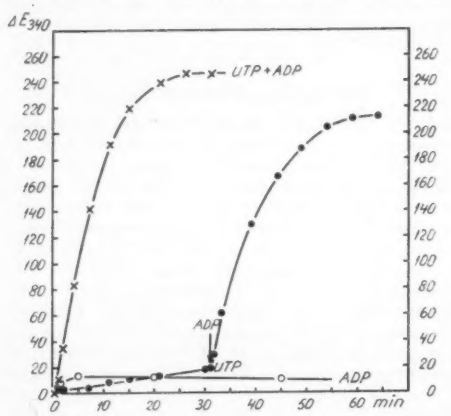


Fig. 1. Effect of adenosine diphosphate on the phosphorylation of glucose by uridine triphosphate.
Abscissa: time in minutes; ordinate: extinction × 10^3 at 340 mμ.
The components of the reaction mixture were: *M*/10 *tris*-hydroxymethyl aminomethane buffer pH 8·2; *M*/100 magnesium chloride; *M*/60 glucose; *M*/5,000 triphosphopyridine nucleotide; *M*/20,000 adenosine diphosphate (added where indicated); *M*/20,000 uridine triphosphate (added where indicated); hexokinase, 'nucleoside diphosphokinase' and glucose-6-phosphate dehydrogenase as a yeast protein fraction 0·5 mgm.; total volume, 1·0 ml.

derived from chromatographic analysis. This technique would thus seem to offer a rapid and sensitive assay for nucleoside triphosphates.

It appears likely that the previously reported formation of uridine diphosphoglucose from adenosine triphosphate and uridine diphosphate in the presence of glucose-1-phosphate[6] involved 'nucleoside diphosphokinase', since uridine triphosphate and glucose-1-phosphate react to form uridine diphosphoglucose[5].

It is also possible that the previously reported slow rate of glucose phosphorylation by uridine triphosphate[7] and inosine triphosphate[8] may be due entirely or in part to the contamination of these compounds by traces of adenosine diphosphate, since 'nucleoside diphosphokinase' occurs in the hexokinase and *Zwischenferment* preparations used to test these potential phosphate donors.

We would like to thank Dr. H. M. Kalckar for his encouragement and continued interest during this work.

P. BERG*
W. K. JOKLIK†

Institute for Cytophysiology,
University of Copenhagen.

* Research Fellow of the American Cancer Society recommended by the Committee on Growth, National Research Council.
† Research Fellow of the Australian National University. Present address: Department of Microbiology, Australian National University, Canberra.

[1] Berger, L., Slein, M. W., Colowick, S. P., and Cori, C. F., *J. Gen. Physiol.*, **29**, 379 (1946).
[2] LePage, G. A., and Mueller, G. C., *J. Biol. Chem.*, **180**, 975 (1949).
[3] Warburg, O., and Christian, W., *Biochem. Z.*, **254**, 438 (1938).
[4] Slein, M. W., Cori, G. T., and Cori, C. F., *J. Biol. Chem.*, **186**, 763 (1950).
[5] Munch-Petersen, A., Kalckar, H. M., Cutulo, E., and Smith, E. B., *Nature* (in the press).
[6] Trucco, R. E., *Arch. Biochem.*, **34**, 482 (1951).
[7] Kleinzeller, A., *Biochem. J.*, **36**, 729 (1942).
[8] Kornberg, A., "Symposium on Phosphorus Metabolism", **1**, 392 (1951).

Culture of *Fucus* Hybrids

IT has long been known that cross-fertilization could be carried out between any two of the three species of *Fucus*, *Fucus spiralis* L., *Fucus vesiculosus* L. and *Fucus serratus* L., and that sometimes quite a high percentage of hybrid zygotes would result[1–3]. There are no records, however, of the growth of hybrid sporelings in culture beyond the first few segmentations. There are also only very few satisfactory records of naturally occurring hybrids, though it might be assumed, since the cross can be made quite readily in culture, that it would also frequently occur in the sea.

We have recently[3] described two *Fucus* populations, one produced as the result of a clearance experiment on the shore at Port St. Mary, Isle of Man, and the other occurring naturally on the sandstone bank of the River Mersey at Eastham, Cheshire, populations which we believe to be hybrid swarms among the three *Fucus* species mentioned above.

Since fertilized eggs of hybrid origin are known to segment, and suspecting that hybrid populations occur naturally, it seemed at least possible that hybrids could be raised in culture. Attempts to raise such hybrids have been successful, and we have sporelings of *Fucus serratus* L., *Fucus vesiculosus* var. *evesiculosus* Cotton and the two reciprocal crosses between these two species growing in culture. The hybrids appear to develop as readily as the parent

Fig. 1. Sporelings of *Fucus vesiculosus* var. *evesiculosus* ♀ × *F. serratus* ♂, 4 months old

species. All have reached a comparable stage and at four months old are 4–7 mm. in length. Although the majority are still in the cylindrical stage with well-developed apical hairs (Fig. 1), some have already flattened and are producing cryptostomata.

The sporelings have been raised on glass slides and small stones in glass vessels containing Erdschreiber culture solution in sea-water. The vessels are suspended in a constant-temperature culture tank kept at 10° C. and lighted from above by 'Daylight' fluorescent tubes for 18 hr. each day. No attempt has yet been made to imitate conditions of tidal exposure, and this has not appeared to be necessary.

We wish to thank Prof. N. A. Burges, in whose Department this work is being carried out.

E. M. Burrows

Hartley Botanical Laboratories,
University of Liverpool,
Liverpool 3.

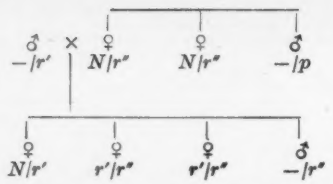
S. M. Lodge

Marine Biological Station,
Port Erin,
Isle of Man.

[1] Thuret, G., *Ann. Sci. Nat.*, **4**, 197 (1854).
[2] Kniep, H., *Flora*, **118–9**, 331 (1925).
[3] Burrows and Lodge, *J. Mar. Biol. Assoc.*, **30**, 161 (1951).

A Pedigree for Three Types of Colour-Vision Defect

The following pedigree is of interest because it shows three types of red-green colour vision defect together, namely, protanopia (*P*), extreme protanomaly (*EPA*) and protanomaly (*PA*) with darkened red, and because it supports the theory that *PA* is dominant to *EPA*[1,2].



The gene for *P* is represented as *p*, that for *EPA* as r'' and that for *PA* with darkened red as r'. *N* is the normal gene of the 'protan' series, and the gene for *PA* with red of normal brightness would be shown as *r* but does not appear in this pedigree.

The maternal uncle is a protanopic dichromat. He must have inherited his defect from his mother. The father is protanomalous with darkened red. The mother and her sister are presumably *EPA*-normal heterozygotes, their defective genes having come from their father. The first daughter is normal in colour vision and must be a *PA*-normal heterozygote. The second and third daughters are protanomalous and must be *PA*–*EPA* heterozygotes in which r' is dominant to r''. The son is an *EPA* subject and must be a hemizygote for the gene r''.

The second daughter is exactly like her father in colour vision, but the third daughter is slightly more defective, in the sense that she has a larger matching range but a smaller mean deviation. In order to account for this, it must be assumed that in her the gene r'' has more penetrance than in her sister, owing to unknown physiological differences, and that in her r' is incompletely dominant to it. The brother is much more defective, and includes the normal matching point in his matching range, but he is far from being a dichromat. All defectives in this pedigree failed the Ishihara test unequivocally and it did not distinguish them from each other.

R. W. Pickford

Department of Psychology,
The University,
Glasgow, W.2. Aug. 10.

[1] Franceschetti, A., *Schweiz. Med. Wchsch.*, **58**, 52, 1273 (1928).
[2] Pickford, R. W., "Individual Differences in Colour Vision", 361 (London, 1951).

Zoological Nomenclature

Notice is hereby given that the International Commission on Zoological Nomenclature has under consideration the following cases involving the possible use of its plenary powers for the purposes specified against each entry. Full particulars of these cases have been published in the *Bulletin of Zoological Nomenclature* in Double-Part 4/5 of Volume 9. (1) *Astacus* Fabricius, 1775 (Class Crustacea, Order Decapoda), validation of (correction of an error in *Opinion* 104); (2) *Favus* Lanchester, 1900 (Class Crustacea, Order Decapoda), validation of (correction of an error in *Opinion* 73); (3) *flavipes* Olivier, 1795, *Dytiscus* (Class Insecta, Order Coleoptera), validation of, by the suppression of *flavipes* Fabricius, 1792, *Dytiscus*.

Comments on the above cases should be sent as soon as possible to me.

Francis Hemming
(Secretary to the International Commission on Zoological Nomenclature)

28 Park Village East,
Regent's Park, London, N.W.1.

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, November 30

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Anniversary Meeting.

BRITISH SOCIETY FOR THE HISTORY OF SCIENCE (in the Lecture Room, Science Museum, South Kensington, London, S.W.7), at 5.30 p.m.—Dr. H. R. Calvert: "The Scientific Work and Inventions of Charles, 3rd Earl Stanhope".

Tuesday, December 1

UNIVERSITY OF LONDON (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. R. A. Stirton (California): "Australian Mammalian Fauna and its Origin".*

ROYAL AERONAUTICAL SOCIETY (in the Library, 4 Hamilton Place, London, W.1), at 7 p.m.—Mr. K. L. G. Legg: "Integral Construction".

Wednesday, December 2

BRITISH PSYCHOLOGICAL SOCIETY, INDUSTRIAL SECTION (in Room 105, London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 1 p.m.—Dr. R. Harper: "The Assessment of Foodstuffs".

INSTITUTE OF PETROLEUM (at 26 Portland Place, London, W.1), at 5.30 p.m.—Dr. F. P. Bowden, F.R.S.: "The Friction of Solids" (Redwood Lecture).

INSTITUTION OF ELECTRICAL ENGINEERS, RADIO SECTION (at Savoy Place, London, W.C.2), at 5.30 p.m.—Mr. T. Hayton, Mr. C. J. Hughes and Mr. R. L. Saunders: "Telegraph Codes and Code Convertors"; Mr. R. O. Carter and Mr. L. K. Wheeler: "Code Convertors for the Interconnection of Morse and Teleprinter Systems".

ASLIB, ECONOMICS GROUP (at The Goldsmiths' Hall, Foster Lane, London, E.C.2), at 6 p.m.—Mr. D. E. Lock: "Statistics: their Compilation"; Mr. W. Davies: "Statistics: their Use"; and Dr. H. Durant: "Statistics: their Application".

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS (at the Chemical Society, Burlington House, London, W.1), at 7 p.m. Prof. C. H. Gray: "Recent Advances in Medical Chemistry".

WOOL EDUCATION SOCIETY (in the Lecture Hall, Royal Society of Arts, John Adam Street, Adelphi, London, W.C.2), at 7.30 p.m.—Dr. Arthur Raistrick: "The Role of the Yorkshire Cistercian Monasteries in the History of the Wool Trade in England".

SOCIETY OF COSMETIC CHEMISTS OF GREAT BRITAIN (at the St. Ermin's Hotel, Caxton Street, London, S.W.1), at 7.45 p.m.—Dr. J. H. Schulman: "Molecular Interactions at the Solid-Liquid Interface with Special Reference to Emulsions Stabilized with Solid Particles".

Thursday, December 3

INSTITUTE OF LARYNGOLOGY AND OTOLOGY (at the Royal College of Surgeons, Lincoln's Inn Fields, London, W.C.2), at 5.30 p.m.—Dr. Michael Ward: "The Ascent of Mount Everest: Medical Problems".*

INSTITUTE OF PHYSICS, LONDON AND HOME COUNTIES BRANCH (at 47 Belgrave Square, London, S.W.1), at 5.30 p.m.—Dr. J. Topping: "The Use of Approximations in Physics".

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, London, W.C.2), at 5.30 p.m.—Mr. W. S. Procter, Mr. M. J. L. Pulling and Mr. F. Williams: "Technical Arrangements for the Sound and Television Broadcasts of the Coronation Ceremonies on June 2, 1953".

SOCIETY OF CHEMICAL INDUSTRY, MICROBIOLOGY GROUP (at the Medical Society of London, 11 Chandos Street, Cavendish Square, London, W.1), at 6.15 p.m.—Scientific Papers on "Dextran". (Speakers: Prof. M. Stacey, F.R.S., Mr. A. E. James, Dr. F. Fletcher, Mr. A. R. Lockwood and Mr. A. W. Wilkinson.)

CHEMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 7.30 p.m.—Scientific Papers.

Friday, December 4

INSTITUTION OF MECHANICAL ENGINEERS (at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Mr. W. E. Bardgett and Dr. C. L. Clark: "Comparative High Temperature Properties of British and American Steels"; Dr. R. W. Bailey, F.R.S.: "A Critical Examination of Procedures Used in Britain and the United States to Determine Creep Stresses for the Design of Power Plant for Long Life at High Temperatures".

BRITISH GLACIOLOGICAL SOCIETY (at the Scott Polar Research Institute, Cambridge), at 8.30 p.m.—Dr. W. S. Rogers and Dr. Irena Modlibowska: "Frost Damage to Plants".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m.—Prof. N. F. Mott, F.R.S.: "Dislocation, Fracture and Fatigue".

Saturday, December 5

ASSOCIATION OF AGRICULTURE, and BRITISH AGRICULTURAL HISTORY SOCIETY (at the Institute of Education, University of London, Malet Street, London, W.C.1), at 10.30 a.m.—Conference on "Studies in Regional History".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT, Grade B, IN MATHEMATICS, and an ASSISTANT, Grade A, IN MATHEMATICS AND SCIENCE, at Derby Technical College—The Principal, Derby Technical College, Normanton Road, Derby (December 5).

ASSISTANT, GRADE B (with good qualifications in physics, and preferably with teaching and/or industrial experience), IN THE DEPARTMENT OF PHYSICS AND MATHEMATICS—The Registrar, College of Technology, Suffolk Street, Birmingham 1 (December 5).

LECTURER (with good honours degree in chemistry, and research or industrial experience in physical or inorganic chemistry) IN CHEMISTRY—The Registrar, The Technical College, Sunderland, Co. Durham (December 5).

PHYSICAL CHEMIST (preferably with experience in the macromolecular field)—for a senior research post—The Director, Brewing Industry Research Association, Nutfield, Surrey (December 5).

SENIOR LECTURER (with honours degree, and preferably with industrial and teaching experience) IN THE DEPARTMENT OF CHEMISTRY—The Registrar, College of Technology, Suffolk Street, Birmingham 1 (December 5).

RESEARCH ASSISTANT (graduate in physics or mechanical science) IN PHYSICS, to carry out fundamental studies on stress waves in solids—The Registrar, University College of Wales, Aberystwyth (December 7).

SECRETARY (male, with university degree and experience of administration and editing, and preferably with a knowledge of science)—The Secretary, British Association, Burlington House, Piccadilly, London, W.1 (December 11).

CHEMIST and PHYSICIST (with at least H.S.C. (science) or equivalent, and preferably with experience in analytical chemistry, corrosion of metals, biochemistry, meteorology or physical testing, including optics), at the Ministry of Supply Tropical Testing Establishment, Port Harcourt, Nigeria, to assist in study of effects of tropical conditions on service materials and equipment—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting F.591/53A (December 12).

MATHEMATICIANS (Scientific Officer, Assistant Experimental Officer and Experimental Officer grades) in Ministry of Supply Research and Development Establishments, mainly in the South of England, for work which includes research into aerodynamics and aircraft structures, high speed electronic computors, radio and radar, including aerial design and radiation problems, engineering problems, and trials work—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.117/53A (December 12).

SENIOR RESEARCH ASSISTANT (preferably of Ph.D. standing, and with experience of X-ray techniques, including counters), and a RESEARCH ASSISTANT (with experience in vacuum or electronic techniques) IN THE ELECTRON MICROSCOPE SECTION of the Cavendish Laboratory, in connexion with the work which is being carried out on the X-ray microscope—The Secretary, Department of Physics, Cavendish Laboratory, Free School Lane, Cambridge (December 12).

FUEL TECHNOLOGIST (Coke Technical Officer) to be responsible for advising on all technical aspects of coke development—The Secretary, North Western Gas Board, Bridgewater House, 60 Whitworth Street, Manchester 1 (December 14).

CHAIR OF BACTERIOLOGY in the Faculty of Medicine—The Secretary, Queen's University, Belfast (December 15).

SENIOR LECTURER or LECTURER (Grade A) IN PHYSICS, and LECTURERS (Grade A or B) IN BOTANY, ZOOLOGY, CHEMISTRY and MATHEMATICS at the Kumasi College of Technology, Gold Coast—The Secretary, Advisory Committee on Colonial Colleges, 1 Gordon Square, London, W.C.1 (December 15).

ASSISTANT EXPERIMENTAL OFFICER (with a pass degree in botany or other suitable qualification) at the WELSH PLANT BREEDING STATION, for work in grass and clover breeding—The Registrar, University College of Wales, Aberystwyth (December 19).

CHAIR OF PHILOSOPHY—The Registrar, The University, Liverpool (December 19).

SCIENTISTS (with good honours degree, or equivalent in a science subject, and preferably with a sound background in geology and chemistry) IN THE COAL SURVEY LABORATORIES at Glasgow and Nottingham, for work which will include the preparation of detailed reports on the structure and physical and chemical properties of the coal seams covered by these laboratories—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting TT/705 (December 19).

LECTURER IN AGRICULTURAL CHEMISTRY at the University College of the Gold Coast—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (December 31).

PLANT PATHOLOGISTS (graduates from a recognized university, with some postgraduate experience and training in plant pathology) in the Tobacco Research Board of Southern Rhodesia—The Director, Tobacco Research Board of Southern Rhodesia, P.O. Box 1909, Salisbury, Southern Rhodesia (December 31).

SCIENTIFIC ASSISTANT (with a degree in a biological science, and some knowledge of languages) IN THE COMMONWEALTH BUREAU OF ANIMAL HEALTH—The Director, Commonwealth Bureau of Animal Health, Veterinary Laboratory, New Haw, Weybridge, Surrey (January 1).

PROFESSOR OF PSYCHOLOGY at the University of Cape Town, South Africa—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (January 25).

AGRICULTURAL OFFICERS (with a degree in agriculture, and not less than two years postgraduate training or experience in agriculture) in the Colonial Territories (at present mainly in East and West Africa and Fiji)—The Director of Recruitment (Colonial Service), Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting CDE.68/01.

ASSISTANT LECTURER IN AGRICULTURAL BOTANY (Plant Pathology)—The Bursar, Royal Agricultural College, Cirencester.

CHEMIST (graduate or equivalent) for research on the drying of printing inks, with special reference to the influence of paper—Printing, Packaging and Allied Trades Research Association, Randalls Road, Leatherhead, Surrey.

CHEMIST (with first- or second-class honours degree with chemistry as the principal subject, or an equivalent qualification) with the Pyrethrum Board of Kenya, to take charge of chemical laboratories in Nakuru dealing with the analysis of pyrethrum flowers and with chemical investigations in connexion with the growing, preparation and marketing of the material—Box "OC/176", c/o 95 Bishopsgate, London, E.C.2.

ELECTRICAL ENGINEERS (preferably graduates or corporate members of I.E.E. or I.M.E., and with sound training and appropriate experience) with the Central Electricity Board, Federation of Malaya—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M2C/28770/T.A.

ENTOMOLOGIST (experienced) with the Empire Cotton Growing Corporation, to take charge of research on cotton pests at their principal research station near Kampala, Uganda—The Secretary, Empire Cotton Growing Corporation, 12 Chantrey House, Eccleston Street, London, S.W.1.

ENTOMOLOGISTS (2) in the Colonial Insecticides Research Unit, Tanganyika—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting CDE.87/8/01.

EXPERIMENTAL OFFICER or ASSISTANT EXPERIMENTAL OFFICER at the National Physical Laboratory, Teddington, for work on design of research equipment and instruments—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting C.588/53A.

EXPERIMENTAL OFFICERS (with at least H.S.C. (chemistry) or equivalent) (Ref. F.139/53A); and ASSISTANTS (Scientific) (Ref. F.140/53A) IN THE CHEMICAL INSPECTORATE, Ministry of Supply, for analytical work on atomic energy materials in N.W. England, and for general analytical work in various localities in England and Wales—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King St., London, S.W.1, quoting appropriate Ref. No.

LECTURER or ASSISTANT LECTURER IN ANIMAL PHYSIOLOGY—The Secretary and Registrar, The University, Southampton.

MATHEMATICIAN (with good honours degree) at the British Rayon Research Association, to programme work to their electronic digital computer—The Secretary, British Rayon Research Association, Barton Dock Road, Urmston, Manchester.

MECHANICAL ENGINEERS, AERODYNAMICISTS, PHYSICISTS, CHEMISTS, METALLURGISTS and MATHEMATICIANS in the Ministry of Supply, National Gas Turbine Establishment, near Farnborough, Hants—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.294/53A.

PHYSICIST (with good honours degree) to assist in research into the fundamental principles underlying the processing of textile fibres into yarns—The Secretary, The British Jute Trade Research Association, Kinnoull Road, Kingsway West, Dundee, quoting Ref. N/1.

PHYSICISTS (with sound basic training, and prepared to apply their knowledge to problems from many fields including aerodynamics and aircraft structures, aircraft instruments, armaments, electronic circuits, radio and radar) at Ministry of Supply Research and Development Establishments, for duties mainly experimental, but may include trials work—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.170/53A.

PLANT PHYSIOLOGIST (with good honours degree and postgraduate research experience) to direct and undertake fundamental biochemical investigations with a view to the ultimate development of mass culture technique for the lesser known marine algae of potential industrial value—The Secretary, Institute of Seaweed Research, Inveresk, Midlothian.

PRINCIPAL SCIENTIFIC OFFICERS (2), (*a*) MECHANICAL AND ELECTRICAL ENGINEER (with first- or second-class honours degree or equivalent qualifications, and preferably with a knowledge of metallurgy) (Ref. C.606/53A); (*b*) PHYSICIST (with first- or second-class honours degree or equivalent qualifications, and preferably with industrial experience) (Ref. A.298/53A), at the National Physical Laboratory, Teddington, for scientific information services—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting appropriate Ref. No.

RESEARCH CHEMIST (with good honours degree in chemistry, preferably with Ph.D., or equivalent research experience) in the British Boot, Shoe and Allied Trades Research Association, to study effects of foot sweat on shoe leather and other related problems—The Director of Research, Satra House, Rockingham Road, Kettering, Northants.

SCIENTIFIC OFFICER or SENIOR SCIENTIFIC OFFICER (with first- or second-class honours degree or equivalent, and sound knowledge of properties and structure of metals and alloys) to investigate characteristics of radioactive alloy systems (Ref. A.295/53A); EXPERIMENTAL OFFICERS or ASSISTANT EXPERIMENTAL OFFICERS (with at least H.S.C. (science) or equivalent) to work on (*a*) investigations on radioactive alloy systems, (*b*) determination of physical properties (for example, thermal expansion, electrical resistance, specific heat) of radioactive metals (Ref. A.296/53A), at the Atomic Energy Research Establishment, Harwell, Berks—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting appropriate Ref. No.

SCIENTIFIC OFFICERS (with first- or second-class honours degree in physics or electrical engineering or equivalent), and ASSISTANT EXPERIMENTAL OFFICERS (with H.S.C. (science) or equivalent) at the Ministry of Supply, London Headquarters, for research and development of electronic equipment, including guided weapons—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting D.446/53A.

SENIOR BIOCHEMIST (with appropriate university science degree or A.R.I.C., or equivalent qualification, and wide experience in biochemical work) at the Derbyshire Royal Infirmary, Derby—The Secretary, Derby No. 1 Hospital Management Committee, Babington Buildings, Babington Lane, Derby.

TECHNICAL ASSISTANT (graduate in mathematical and/or physical science) IN THE SCHOOL OF THEORETICAL PHYSICS—The Registrar, Dublin Institute for Advanced Studies, 64 Merrion Square, Dublin.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

A Reformed Calendar: Some Social and Religious Aspects. By the Rt. Hon. Lord Merthyr. Pp. 24. (London: World Calendar Association, 1953.) 1*s*. [189

Department of Scientific and Industrial Research. Fuel Research, Technical Paper No. 57: Catalytic Enrichment of Industrial Gases by the Synthesis of Methane. Pp. iv+51+4 plates. (London: H.M. Stationery Office, 1953.) 2*s*. net. [189

Iodine for Small Animals. Pp. 20. (London: Chilean Iodine Educational Bureau, 1953.) [239

Royal Entomological Society of London. Handbooks for the Identification of British Insects. Vol. 4, Part 3: Coleoptera: Hydradephaga. By F. Balfour-Browne. Pp. 34. 6*s*. Vol. 5, Part 7: Coleoptera: Coccinellidæ and Sphindidæ. By R. D. Pope. Pp. 12. 2*s*. 6*d*. Vol. 5, Part 15: Coleoptera: Scolytidæ and Platypodidæ. By E. A. J. Duffy. Pp. 18. 3*s*. 6*d*. Vol. 10, Part 1: Diptera: Syrphidæ. By R. L. Coe. Pp. 98. 17*s*. 6*d*. [239

The Registrar General's Decennial Supplement, England and Wales, 1931. Part IIB: Occupational Fertility, 1931 and 1939. Pp. vi+90. (London: H.M. Stationery Office, 1953.) 13*s*. 6*d*. net. [239

World Power Conference. Annual Report, 1952. Pp. 22. (London: World Power Conference, 1953.) 1*s*. 6*d*. [249

Scientific Proceedings of the Royal Dublin Society. Vol. 26 (N.S.), No. 10, 24 July, 1953: The Uranium Content of some Specimens of Phosphate Rock. By C. F. G. Delaney, C. M. E. Matthews and J. H. J. Poole. Pp. 165–172. No. 11, 9th September, 1953: The Use of Two Scintillation Counters in Beta Ray Spectroscopy. By C. F. G. Delaney. Pp. 173–178+1 plate. 2*s*. (Dublin: Royal Dublin Society, 1953.) [250

Other Countries

Institut Royal des Sciences Naturelles de Belgique. Expédition Océanographique Belge dans les Eaux Côtières Africaines de l'Atlantique Sud (1948–1949). Résultats Scientifiques. Vol. 4, Fascicule 4: Annélides Polychètes non Pélagiques. Par Pierre Fauvel (Angers). Pp. 56. Exploration Hydrobiologique du Lac Tanganika (1946–1947). Résultats Scientifiques. Vol. 3, Fascicule 5A: Poissons non Cichlidæ. Par Max Poll (Tervuren). Pp. 251+11 plates. (Bruxelles: Institut Royal des Sciences Naturelles de Belgique, 1953.) [189

Académie Royale de Belgique. Classe des Sciences. Mémoires, Tome 28, Fascicule 3: Quelques propriétés nouvelles des courbes tracées sur une surface algébrique. Par Louis Nollet. Pp. 40. (No. 1641.) (Bruxelles: Academie Royale de Belgique, 1953.) 40 francs. [239

l'Institut pour l'Encouragement de la Recherche Scientifique dans l'Industrie et l'Agriculture. Comtes rendus de recherches. No. 12, September, 1953: Travaux du Laboratoire de Technologie des Matières Textiles de l'Université de Gand. Étude des cotons Congolais. Relations entre les principes caractéristiques de fibres et la résistance du fil. Par Prof. D. De Meulemeester, Ir. G. Raes et Ir. T. Fransen. Pp. 125. (Bruxelles: l'Institut pour l'Encouragement de la Recherche Scientifique dans l'Industrie et l'Agriculture, 1953.) 115 francs. [239

Carnegie Institution of Washington. Contributions to Paleontology. Fossil Plants of the Florissant Beds, Colorado. By Harry D. MacGinitie. Pp. iii+198+75 plates. (Publication No. 599.) (Washington, D.C.: Carnegie Institution of Washington, 1953.) Paper 5.25 dollars; Cloth 5.75 dollars. [239

Bulletin of the American Museum of Natural History. Vol. 102, Article 4: The Spider Genera *Xysticus*, *Coriarachne*, and *Oxyptila* (Thomisidæ, Misumeninæ) in North America. By Willis J. Gertsch. Pp. 413–482. (New York: American Museum of Natural History, 1953.) 1 dollar. [239

Imperial College of Tropical Agriculture. Report of the Governing Body and the Acting Principal's Report for the period 1st October, 1950, to 30th September, 1952. Pp. 48. (St. Augustine, Trinidad and London: Imperial College of Tropical Agriculture, 1953.) [239

Smithsonian Miscellaneous Collections. Vol. 121, No. 12: The Pleistocene Fauna of Walles Bluff and Langleys Bluff, Maryland. By S. F. Blake. Pp. 32+1 plate. (Publication 4129.) Vol. 122, No. 1: Long-range Effects of the Sun's Variation on the Temperature of Washington, D.C. By C. G. Abbot. Pp. 14. (Publication 4131.) Vol. 122, No. 2: New and Inadequately Known North American Species of the Copepod Genus Diaptomus. By Mildred Stratton Wilson. Pp. 30. (Publication 4132.) Vol. 122, No. 4: Solar Variation: a Leading Weather Element. By C. G. Abbot. Pp. 35. (Publication 4135.) Vol. 122, No. 5: Silver-disk Pyrheliometry. By W. H. Hoover and A. G. Froiland. Pp. 10+1 plate. (Publication 4136.) (Washington, D.C.: Smithsonian Institution, 1953.) [259

Journal of the West African Institute for Oil Palm Research. No. 1, September 1953. Pp. 100+22 plates. (Benin City: West African Institute for Oil Palm Research; London: Crown Agents for the Colonies, 1953.) 2*s*. 6*d*. [110

Annual Report of the Director of the Museum of Comparative Zoology at Harvard College to the Provost of Harvard University, for 1951–52. Pp. 19. (Cambridge, Mass.: Museum of Comparative Zoology at Harvard University, 1952.) [110

Bulletin of the Museum of Comparative Zoology at Harvard College. Vol. 109, No. 3: New and Little Known Sharks from the Atlantic and from the Gulf of Mexico. By Henry B. Bigelow, William C. Schroeder and Stewart Springer. Pp. 213–276. Vol. 110, No. 3: Zoological Results of a Fifth Expedition to East Africa (3) Reptiles from Nyasaland and Tete. By Arthur Loveridge. Pp. 141–322+5 plates. Vol. 110, No. 4: Zoological Results of a Fifth Expedition to East Africa (4) Amphibians from Nyasaland and Tete. By Arthur Loveridge. Pp. 323–406+4 plates. Vol. 110, No. 5: Zoological Results of a Fifth Expedition to East Africa (5) Chilopoda (*Myriopoda*). By R. F. Lawrence. Pp. 407–424. Vol. 110, No. 6: Zoological Results of a Fifth Expedition to East Africa (6) Decapod Crustacea. By Fenner A. Chace, Jr. Pp. 425–444. (Cambridge, Mass.: Museum of Comparative Zoology and Harvard University, 1953.) [110